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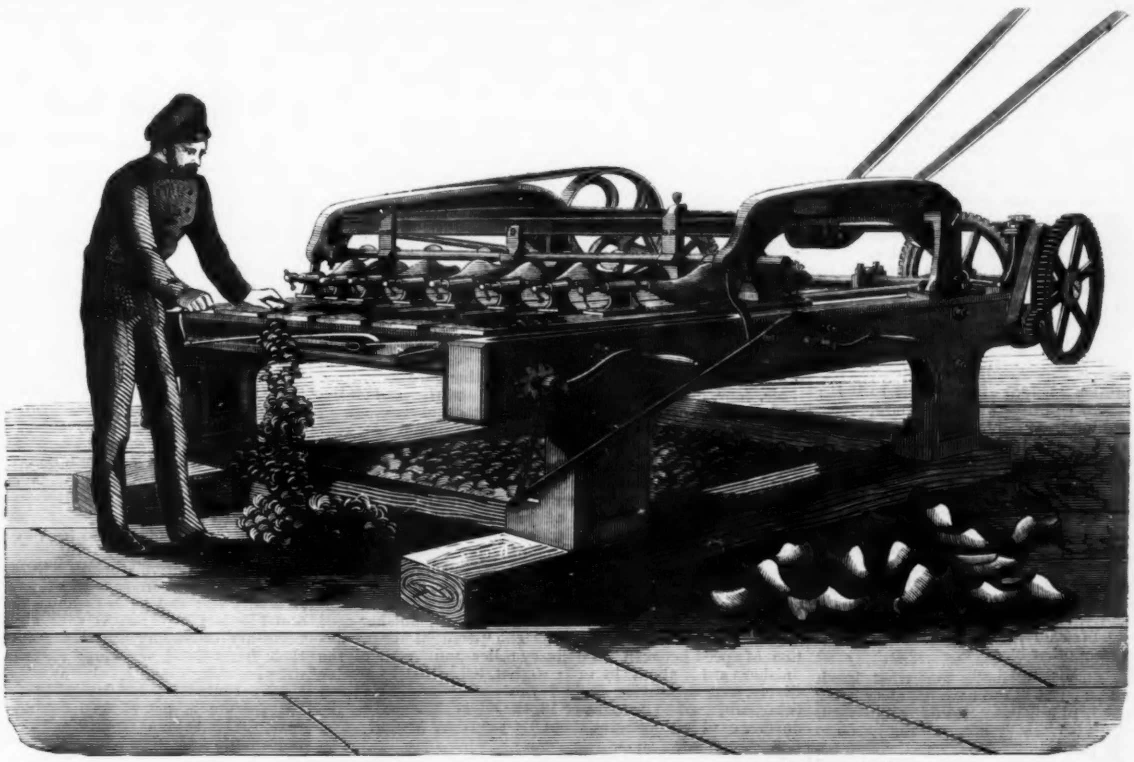

FIG. 1.—MACHINERY FOR MAKING WOODEN SHOES.

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WOODEN shoes are extensively used in France, and their manufacture constitutes a large industry. Machines for this purpose are made by Mr. Arbey, of 41 Cours de Vincennes, Paris.

These machines have a solid construction, work regularly, and may be managed by any workingman, even should he have no knowledge of the hand manufacture of wooden shoes. After the wooden blocks have been brought by circular saw to the proper size they are submitted to the action of a Blanchard lathe or shaping machine (shown in Fig 1), which gives them their exterior form, corresponding to the iron patterns used for that purpose. This machine is so constructed that it can be regulated to suit different sizes without altering the shape of the shoe.

When the pieces of wood have received their exterior shape they are placed in a machine which hollows out the inside (Fig. 2), and their finishing touch they receive in the machine (Fig. 3), which shapes the sole.

Nothing remains but to cut off the bulge at the back above the heel by means of the circular saw.

A single workingman is sufficient for each of the machines; and their productiveness is so great that in that

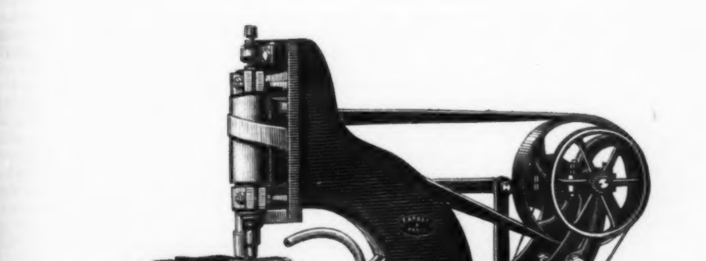


FIG. 2. MACHINERY FOR MAKING WOODEN SHOES. FIG. 3.

which shapes six at a time, from 150 to 180 pairs are manufactured in a day.

In these different machines can be made large, medium, and small shoes, for the right foot and the left, and of any size whatever, without altering the shape.

The machine for shaping six shoes at a time costs $800, that for hollowing the interior $360, and the finishing machine $600.

ON THE MANUFACTURE OF JUTE.*

By MR. WILLIAM FLEMING, of Barrow-in-Furness.

WHILE jute has long been known to the natives of Bengal, and largely used by them in various textile manufactures and for paper-making purposes, its introduction into this country is of comparatively recent date.

In 1796 the East India Company imported some small quantities of jute, and afterward continued importing it in small quantities now and then; but it made no progress whatever with the manufacturers of this country. What was thus imported seems to have been employed in the neighborhood of London, in the production of door mats, ropes, etc. Portions of the samples, however, appear to have found their way to Abingdon, in Oxfordshire, where there were a few manufacturers of sackings and woolen carpetings. There it was spun by hand, and used up to a small extent in some of their fabrics. The Abingdon manufacturers, therefore, appear to have the credit of being the first to employ jute in textile fabrics in this country.

About 1833 some of the jute yarn thus spun at Abingdon was sent to Dundee, where the matter attracted attention; and shortly afterward was commenced at Dundee that manufacture of jute which has resulted in such an extraordinary development of this industry in Great Britain, Ireland, and the Continent. The increase in the consumption of jute during the last fifty years is most remarkable. The total export of jute from Calcutta in 1829-30 amounted to 20 tons, valued at £60; it has now risen (in addition to the enormous consumption for manufacturing purposes in Bengal itself) to upward of 350,000 tons, or nearly 2,000,000 bales annually, amounting in value to about £6,000,000.

Jute is mainly grown in Bengal, and exported from Calcutta. It is sown in March and April, and during the following three months attains a height of from 10 ft. to 12 ft., while the stems reach from 1 in. to 2 in. in circumference.

Shortly after the plant has flowered it is cut down near to the ground, tied up in bundles of from 50 to 100 plants each, and "retted," that is, steeped in stagnant water from eight to ten days, till the "bast" (or the fiber lying between the bark and the stem) can be separated from the wood. It is then removed from the water and beaten gently against a board until, with a little management, the native operator can strip off the whole from the stem without damage to either stem or fiber. The fiber is then drawn through the water until all impurities are washed or picked off. It is then dried in the sun, and after having been assorted into different grades of quality, is exported, under various distinctive marks, in bales of 400 lb. each, to London, Liverpool, Dundee, Barrow, and other markets.

Softening.—The jute fiber, being of a somewhat harsh nature, the first process which it has to undergo after being released from the bale where it is very tightly compressed, is that of softening. This is done by dividing the jute into stricks or handfuls, and passing these stricks through between a series of heavy fluted rollers, which by crimping and crushing, and in a manner rubbing the fibers, render them softer and more yielding.

The softening machine consists of four horizontal rows of fluted rollers about 9 in. in diameter and 2 ft. 6 in. long, and ten rollers in each row. Each roller in the bottom or fourth row bears the weight of the three rollers above it; those in the third row are pressed by the weight of two rollers, and those in the second row by the weight of one roller. The stricks of jute pass first between the pairs of rollers constituting the first and second rows, then return between the second and third rows, and pass lastly between the third and fourth rows, being delivered in a softened condition at the opposite end of the machine to that where they were introduced, and having been subjected during the process to an increasing weight as they entered between the different rows. The softening of the jute is at the same time assisted by an operation called "batching," *i. e.*, the sprinkling of the stricks with oil and water while they are passing through the machine. This is done by having two cisterns—one containing water and the other containing oil—placed over the machine. Inside the cisterns are revolving rollers, which lift the liquids and discharge them over a scraper or doctor, dropping them upon the jute as it passes between the rollers.

Breaker Card.—The jute having been softened and weighed into bundles, is conveyed to the breaker card.

The principal parts of this machine consist of a cylinder 4 ft. in diameter by 6 ft. wide on its working surface, covered with sharp steel pins inclined slightly forward in the direction in which the cylinder revolves; and of a number of small rollers arranged around the periphery of the cylinder, each of these rollers being also covered with pointed pins. The stricks of jute are laid or spread by the attendant upon an endless traveling sheet, which conveys them to the first roller called the feeder; and the pins which cover the surface of this roller enter the jute and carry it forward to the point where it comes in contact with the pins of the cylinder. The surface speed of the pins of the feeder being about 10 ft. per minute, while the speed of the pins of the cylinder is about 2,000 ft. per minute, the fibers which are slowly presented and delivered by the feeder receive a severe combing or dressing from the pins on the cylinder before they are finally released by the feeder. The cast-iron shell which incases the feeder for about one-sixth of its circumference serves to keep the fibers embedded in the feeder pins so as to prevent their being carried off by the cylinder before being properly carded. A large quantity of the fiber, however, when struck by the pins of the rapidly revolving cylinder, is broken off and carried forward on the points of the cylinder pins; and it is to straighten out, comb, and split these portions that the other rollers, called workers and strippers, are applied.

The first roller that acts, after the fibers have left the feed roller, is the worker. This roller, which is about 9 in. in diameter, is placed with its pin points at a distance of from $\frac{1}{16}$ to $\frac{1}{8}$ in. from the points of the cylinder pins. The angle of the worker pins is very much more acute than that of the cylinder pins, and inclined in the opposite direction. The roller revolves in the same direction as the cylinder, but at a speed of only about 50 ft. per minute. The effect is that the fibers projecting from the pins of the cylinder are caught on the pins of the slowly revolving worker; and as the direction and pull of the cylinder pins tend to force the fibers on to the pins of the worker, a considerable portion is retained by the latter. The worker is in its turn cleared of fiber by the stripper, a roller about 13 in. in diameter, which revolves at a speed of about 430 ft. per minute in the opposite direction to the worker; and, traveling with pins inclined forward, it strips the fibers from the worker, and is afterward itself cleared by the still more rapidly traveling cylinder.

The same process is repeated at the second worker and stripper, which are placed rather closer to the pins of the cylinder than the first two rollers. After passing the second worker and stripper the fibers are carried forward to the doffer—a roller about 16 in. in diameter which travels in the same direction and at about the same speed as the worker, and has its covering similarly arranged, except that in the doffer the pins are rather finer and more numerous. The pins of this roller are set close to those of the cylinder, so that the whole of the fibers are caught by them and carried round to the two doffing rollers, which take the jute from the doffer in the form of a continuous broad sheet or fleece. This thin sheet of carded jute, after it issues from the doffing roller, is gathered together or contracted from about 5 ft. to 4 in. by means of a tin conductor; and it then passes through the delivery rollers in the form of a continuous sliver, and falls into a can.

The surface speed of the doffing and delivery rollers is generally about fourteen times quicker than that of the feed roller: consequently, if the jute be spread so that the feed roller receives about 2 lb. per yard, the sliver delivered into the can will measure about 7 yards per pound.

The tin rollers shown under the workers and strippers are to prevent the fibers, as much as possible, from falling to the ground when the stripper is clearing the worker.

Finisher Card.—The jute sliver as delivered by the breaker card is not considered to be sufficiently carded for most purposes, and it is therefore necessary that the process of carding should be repeated on a second machine called the finisher card. The principle on which this machine works is exactly the same as that of the breaker card, but instead of only two workers and two strippers, there are sometimes three, four, or five pairs of these rollers, and the pins on the surface of the cylinder and rollers are finer and set closer to one another, so as to comb and split the fibers more efficiently. The finisher card is fed by slivers from twelve cans from the breaker card upon an endless traveling sheet, similar to that used in the breaker card, which carries them forward to be acted upon by the cylinder of the finisher in the same manner as the stricks of jute are acted upon in the breaker card. It will be understood that the slivers as delivered by the breaker card, although continuous, must necessarily be rather irregular, *i. e.*, thicker in some parts than others; but by putting twelve of these already partially carded slivers through the finisher together, a kind of average is struck, and the slivers delivered by the finisher card are much more regular and even. The "draught" or proportion of speed between the delivery roller and feeder of the finisher card is about 16 to 1; so that, being fed by twelve slivers, each measuring about 7 yards per pound, and these being subjected to draught of 16, the sliver delivered by the finisher card will measure about $9\frac{1}{3}$ yards per pound.

Drawing Frame.—The next process after carding is to have the fibers of jute drawn out straight, and laid parallel alongside one another, and this is accomplished on a machine called the drawing frame.

There are several kinds of drawing frame, all intended to produce the same results; but the kind most in use is the system called the "spiral gill drawing frame." In this machine the slivers, which have been delivered into the cans from the finisher card, pass over a conductor plate and thence between three rollers, which are called the retaining rollers, and are in fact the feed rollers of the machine. Just in front of the delivery side of these rollers is a series of traveling bars on which are fixed hackles or gills, *i. e.*, brass stocks with steel pins standing upright in them. These bars, with the gills attached, travel forward from the retaining rollers, carrying with them the jute fibers into which the pins penetrate, their speed being the same as that of the retaining rollers or just as much faster as will insure that the slivers are kept tight and do not rise off the pins. The bars are propelled by means of two longitudinal screws, one at each end of the bar, cut at a pitch varying from $1\frac{1}{2}$ to 2 threads per inch. The end of the bar which enters into the thread of the screw is beveled to the angle of the thread, so that the body of the bar and the pins are quite vertical, while the end fits the spiral; and there being one bar in each thread of the screw, when the screws revolve the bars glide forward, supported on steel slides. These screws are called the top screws, and the length of their threaded part is made suitable for the length of fiber, say about 10 in. or 11 in. for carded jute. As each bar arrives at the front or further end of the top screws, it drops from the slide which has been supporting it in position into the threads of two bottom screws placed exactly under the top screws, cut to the same hand, but revolving in a contrary direction. These bottom screws accordingly carry back the bar, supported on bottom slides and with its pins still upright, to the other end of the frame, where the thread of each screw is terminated by a projecting cam, by which the bar is lifted up into the top screw again, close to the retaining roller, causing the pins of the gills to penetrate the sliver which the retaining roller is delivering. Thus a continuous forward travel of bars is maintained for 10 in. or 11 in. in length in front of the retaining rollers, moving at what is practically the same speed.

At the front or delivering end of the screws, where the bar drops out of the sliver, are the drawing roller and the pressing roller above it, the former being made of steel about $2\frac{1}{2}$ in. in diameter, and the latter generally of cast iron covered with leather, about 8 in. in diameter. These rollers, which are pressed together by means of weighted levers, move at a speed about six or seven times greater than the retaining rollers or gills; consequently the fibers, when delivered by the gills as the traveling bars drop from the top to the bottom screws, are seized between the rollers and drawn away from the pins of the gills, which act as a kind of comb, holding them back and insuring that they do not enter the bite of the rollers in a crossed or tangled state.

The length of each traveling bar is about 3 ft., and there are fixed on it four gills, each 6 in. wide on the pins. Each set of bars and gills, with its retaining and drawing rollers, conductors, etc., constitutes what is called a carriage; and drawing frames are made with one, two, three, four, or five carriages. Thus a drawing frame of two carriages, and four gills per carriage, will have eight sets of gills; and as two slivers from the finisher card are supplied to each gill, the number of cards at the back of the machine will be sixteen. Assuming the speed of the drawing roller to be six times that of the retaining or feeding rollers and gills, it is evident that the sliver delivered by the drawing roller will be six times longer than when it enters the machine; and as there are two card slivers to each gill, and each card sliver may be assumed to measure $9\frac{1}{3}$ yards per pound, the sliver coming from between the drawing and pressing rollers will measure about 28 yards per pound. But for the purpose of completing the process of straightening the fibers and laying them parallel, as well as more effectually equalizing the slivers, it is necessary to put the jute through a second drawing frame; and, therefore, it is more convenient to unite the slivers from two gills upon a doubling plate arranged for the purpose in front of the drawing roller, and so to deliver the sliver from all the eight gills comprised in the two carriages through four pairs of rollers, called delivery rollers, into four cans; the sliver in each can will consequently measure about 14 yards per pound.

The second drawing frame is constructed in an exactly similar manner to the first drawing frame, except that the pins in the gills are rather finer and ranged closer together; and instead of the slivers from two gills being united together in front of the drawing roller, the slivers from each gill are carried straight from the drawing to the delivery rollers and run into the can, thus making eight deliveries from the machine. As there are two slivers, each of 14 yards per pound, put up to each gill, the sliver as delivered into the can from this second drawing frame, if the draught on the machine is six, will measure 42 yards per pound.

Roving Frame.—The next machine in the system of preparing machinery is the roving frame. The object of this machine is to draw out still further the fibers in the jute sliver and wind them on bobbins in a form convenient for the final process of spinning into yarn. The manner of drawing out the slivers is exactly the same as that employed in the drawing frames; but as only one sliver is put up to each gill in the roving frame, and that sliver measures about 42 yards per pound, narrower and smaller gills serve the purpose, and eight gills can be fixed on each bar instead of four; and in consequence of the slivers being so much lighter, the pins of the gills are finer and set closer together. The draught of the roving frame is usually about seven, so that the sliver delivered by the drawing roller of the roving frames will measure about 294 yards per pound.

This is too thin a sliver to deliver into a can; and for that reason and also for general convenience the sliver is twisted slightly and wound on to a bobbin; in this form it is called "rove." In order to twist the sliver into rove and wind it on to the bobbin, there are employed a spindle and flier, constructed on the same principle as in similar machines for cotton and other fibers, but for jute the parts are larger and stronger.

The number of spindles in a jute roving frame may vary from twenty-four to sixty-four; a very usual number to put in is fifty-six; and as there must be a gill for each spindle and flier, seven carriages with eight gills on each bar are necessary to supply fifty-six spindles. The spindles with their fliers stand vertically in two rows in front of the drawing rollers, and revolve at a speed of about 600 revolutions per minute. Inside the flier and turning freely on the spindle is placed the bobbin, which is to receive the rove. This bobbin is driven by gearing independently of the spindle and flier, but revolves in the same direction. The amount of twist given to the rove should be only just sufficient to give it strength to unwind from the bobbin in the subsequent process, without allowing the fibers to separate. Now, suppose the suitable twist for rove to be one turn per inch of sliver delivered; then the speed of the drawing roller must be arranged so as to deliver one inch for each revolution of the flier; and the speed of the bobbin must be calculated to be just sufficiently behind that of the flier to take up the quantity delivered by the drawing rollers. For instance, the spindle and flier make 600 revolutions per minute, the roller delivers 600 in. per minute, and the circumference of the bobbin shank is 5 in.: the speed of the bobbin will have to be 480 revolutions per minute, or 120 less than the flier, because by lagging behind to that extent the bobbin will wind up 120 laps, each 5 in. long, or 600 in. per minute. But as the bobbin fills, the diameter on which it winds continually increases, and the speed must be diminished accordingly.

Thus, when the bobbin is nearly full, its circumference will be 15 in., or three times what it was at starting; consequently the bobbin will have to run out only 40 revolutions per minute behind the flier, in order to wind the rove with one twist per inch. In order to wind the rove regularly from top to bottom of the bobbins, the rail on which these are carried is made to rise and fall, so that the bobbin moves up and down inside the legs of the flier; and the diminution in speed of the bobbin is caused by a projection attached to the lifting rail being arranged to release a catch each time that the rail arrives at top and bottom of its traverse. The regulating motion is obtained from a bowl or pulley with a leather face, which is made to revolve by contact between two flat circular iron disks rotating in contrary directions. Each time that a catch is released either at top or bottom of traverse, the bowl is allowed to slide a little nearer to the center of the two disks, whereby its speed is diminished, and in this way the speed of the bobbin is also reduced for each successive lap that is laid on.

As already explained, the jute fibers in this slightly twisted form are termed "rove." But for the heavier classes of yarn (say when 1 lb. measures less than 400 yards), it is very usual to make the "yarn" on the roving frame. To do this it is only necessary to increase the twist sufficiently to give proper strength to the yarn.

Spinning Frame.—The object of this machine, which completes the first stage in jute manufacturing, is to reduce the rove which comes from the previous machine to the required size, and then to twist the fibers together so as to form what is known as "yarn."

The number of spindles in a spinning frame varies according to circumstances, but for an average class of jute yarns a very usual number is sixty-four on a side, arranged in one row at a pitch or distance from one another of $3\frac{3}{4}$ in. The main parts of the machine are: the rack or creel for the bobbins containing the rove, the retaining rollers, the binding plate, conductor, drawing rollers, thread plate, spindle and flier, and bobbins to receive the yarn. The bobbins containing the rove are placed on pins fixed on the rack, and the rove is introduced through a conducting plate between two fluted rollers pressed together, which form the retaining rollers; then over the binding plate and through a narrow conductor into the bite of the drawing roller and pressing roller, the former being made of iron and the latter of wood, and pressed against the drawing roller by means of steel springs. The drawing and pressing rollers run at a

* Paper read before the Institution of Mechanical Engineers, at Barrow.

surface speed considerably in excess of the retaining rollers, the difference being regulated by change wheels to suit the size of yarn required.

We will assume the drawing roller to be moving seven times faster than the retaining roller, so as to give a draught of seven. The slight twist which the rove has received in the roving frame gives it sufficient consistency to hold together and pull the bobbin round on its pin, so as to supply the retaining rollers; but when gripped at one end between the retaining roller and its pressing roller, and at the other end between the drawing and pressing rollers, the latter pair moving at the quicker speed, the slight twist which the fibers have received does not prevent them from parting. Not being supported by gills as in the drawing and roving frames, the rove is made to press against the binding plate, in order to retain the twist and so prevent the fibers from separating too easily and from passing through the drawing and pressing rollers in an irregular manner.

By the draught of seven, the rove is elongated from 294 yards per pound, as it enters the retaining rollers, to 2,058 yards per pound when it passes from the drawing roller. The fibers are twisted by the spindle and flier in the same manner as in the roving frame, but the amount of twist given to the yarn is very much greater than that given to the rove, and the bobbin is not, as in the roving frame, driven by wheels, but is dragged round after the flier by the thread, and is retarded by friction sufficiently to wind on the yarn, the friction being regulated by the attendant to suit the strength of the yarn.

In illustrating the action of these different machines, a certain weight of jute has been assumed to be laid on the feed sheet of the breaker card, with certain draughts and doublings in the separate subsequent machines, the result of which would be to produce yarn known as "7 lb.," because each "spindle" or length of 14,400 yards would weigh 7 lb., but by varying the weight, draughts, or doublings, other sizes of yarn are produced. The finest yarns in jute made from the best qualities are about 1¾ lb. to 2 lb. per spindle, or say about ¼ lb. per mile; while from the coarsest class yarn is made of which a mile will weigh more than 30 lb.

The yarns, having been prepared in the necessary forms for the looms, are woven into fabrics of great variety, suitable for the requirements of every market in the world, and these fabrics undergo various processes of calendering, mangling, and finishing.

Jute is the cheapest fiber known, and hence the very general demand for jute fabrics in every country. Jute manufactures are now almost entirely used for the conveyance of grain, flour, rice, linseed, coffee, pepper, saltpeter, etc., as also for guano and all chemical manures; while in the export of the raw materials, cotton and wool, nothing else is now employed for packing. All makers of textile goods now use jute hessians and baggings for the packing of their manufactures.

The finer qualities of jute yarns are woven into fabrics suitable for the production of curtain cloths, tapestries, etc., for furniture purposes (such as the "Kalameit," now produced in the Barrow Flax and Jute Works), and for carpets, rugs, etc. They are also used largely in combination with cotton, silk, and woolen yarns, in the weaving of numerous ornamental goods. In fact, the list of the varied purposes to which jute, jute yarns, and jute fabrics are now extensively applied is curious and remarkable, embracing as it does telegraph cables, wire ropes, twines, cords, etc., even down to artificial hair.

The cuttings (or the few inches of hard fiber cut from the bottom of the plant in India) are now largely used by the paper makers in this country as well as in India, America, and the Continent; and the wastes made in the general manufacture of jute which cannot be spun over again come into value in connection with paper making, felt making, and other purposes.

This enormous and general demand has brought about a more than equivalent producing power in this country, in India, and elsewhere; and during the past few years the jute trade has been suffering from the effects of this overproduction; but as the requirements of the world are increasing so rapidly, the improved demand must soon rectify this unfortunate state of things.

PHOTO-LITHOGRAPHY.

WE have several times referred in these columns to the production of photo-lithographic transfer paper. Some prefer to employ for this process albumenized paper, others choose paper which has simply a gelatine surface.

So far as we know albumen is generally favored. It is usual to treat the paper, after it has been sized, with a mixture of

White of egg	5 parts.
Bichromate	1 part.
Water	14 parts.

Or the albumen is applied without bichromate to the paper, and the latter is then sensitized upon a bichromate bath, to which some alcohol has been added, so that the albumen may not dissolve in the sensitizing liquid. The formula best adapted to such a bath is:

Bichromate of ammonium or potassium	1 part.
Water	15 parts.
Alcohol	4 "

The operations of sensitizing, drying, and exposing are well known to our readers.

The treatment of photo-lithographic albumenized paper is a very simple matter, and for this reason it is so commonly used nowadays. The principal advantage of the albumen method lies in the circumstance that you can so easily and quickly apply your ink when once diluted with turpentine. The whole surface of the paper is uniformly treated, the superfluous ink being removed afterward with a soft tuft of cotton wool. The operation, as we have said, is exceedingly simple, and the development of the image afterward, with a sponge dipped in cold water, is rapidly effected.

There is, however, one disadvantage connected with the use of albumenized paper—very delicate shading, like that in maps, etc., is sometimes injured by the mechanical development, if not removed altogether.

Gelatine paper, on the other hand, involves rather more time and trouble. When ink is applied to the dry printed surface (and this is further washed with a sponge to obtain the transfer), there usually remains behind a darkish tone, or, at any rate, a little grease upon the lights, which imparts a gray appearance to the photo-lithograph. For this reason it is usual to dip the gelatine paper bearing the printed image into cold water, blotting it afterward upon filter paper to remove the superfluous moisture prior to the application of the ink roller. But in order that the ink may penetrate sufficiently deep, it is almost indispensable to employ a soft velvet roller upon the gelatine image.

We repeat, that the operations with gelatine are more delicate and laborious than with albumen, but the former permits the reproduction of lines of surpassing fineness, such as albumenized paper fails to yield. We have on several occasions given in these columns particulars regarding the production of gelatine transfer paper; but the process employed at present by the Ordnance Map Office in Vienna has so many advantages that we take this opportunity of briefly referring to it.

In Vienna, for some time past, photography has rendered important assistance in map making. By its aid the tedious process of engraving on metal has been superseded altogether. A draughtsman simply produces the map on a large scale upon paper by means of Indian ink, and this is then photographed and transferred by the ordinary photo-lithographic method. Working in this manner, Austria is able to produce her maps in a fourth the time and probably at one-fortieth the expense incurred by other nations. To Captain Volkmer, we believe, is due, in a great measure, the order of things as they at present exist in Vienna, as also the plan of producing the transfer paper which we here describe.

A sheet of well-sized paper is dipped into water, and, as soon as thoroughly soaked, it is withdrawn and drained. A horizontal glass plate receives the paper, and by means of filter paper and the application of a squeegee all air-bubbles and superfluous moisture are removed. The margins of the paper are bent up to the extent of half an inch to form a tray, and warm gelatine solution poured upon it, one part of gelatine being dissolved in thirty parts of water. The sheets so treated are dried and stored for use. Twenty-four hours before employment the gelatine paper is immersed for three minutes in a saturated solution of bichromate of potash, maintained at as low a temperature as possible. The sheet is then withdrawn, and placed face downward upon patent plate, when filter paper is again applied to remove superfluous liquid and air bubbles. Sensitized paper of this description may be kept in the dark without injury for eight or ten days. Under ordinary circumstances it is thoroughly printed with 15° or 16° of Vogel's photometer.

When printed, the paper is dipped into cold water for a few minutes, and then drawn, face uppermost, upon a glass plate, filter paper being applied to remove superfluous moisture. Should the gelatine swell to such a degree in these circumstances that the finest lines accept ink with difficulty, or not at all, then the printed sheet is first of all immersed for a minute or two in a dilute solution of chrome alum, say of the strength of one part alum to two hundred of water.

Meanwhile, the transfer ink is thoroughly worked up with a little oil of turpentine upon a stone surface; a little of it is applied to an ordinary leather roller, this again worked upon a stone surface, and the ink then applied, in a fine, even surface, to a zinc plate. A little of the ink is now taken up by the aid of a velvet roller, and applied to the moist gelatine image.

Should the gelatine surface, in the meantime, have dried to any extent, it is dipped once more into water and treated as before. Any dirty markings produced in manipulation are removed with a wet sponge, or by gentle rubbing with the finger. Finally, the image is put between sheets of dry blotting paper to absorb the greater part of the moisture, and in an hour afterward is transferred to stone in the lithographic press.

From the results we have seen of this Austrian method, we confidently recommend it in the case of very fine work and for reproductions upon a reduced scale.—*Photographic News.*

PHOTOGRAPHY AND THE INDUSTRIES.

By DR. H. W. VOGEL.

PHOTOGRAPHY, as a young, progressive art, opens up daily new branches of industry. Some time ago it co-operated with engraving and lithography, and it has long since left the workshop of scientific photography to become the helper of the draughtsman, who uses it to reproduce drawings by means of light, under the name of the "Lichtpaus process." But lately it has advanced in other directions, with which its principal aim—the production of prints, which has so long engaged the attention of scientific photographers—is now of minor importance: I mean the application of photography to various industries. As an example may be cited the production of ornamental designs on wood, metal, glass, etc., by means of photography, as they can be easily enlarged or reduced in size.

The first step in this direction were the "burnt-in" photographs on glass or porcelain, and these opened up the field for various decorative purposes. For some time the process was almost entirely employed for the reproduction of portraits or woodcuts, a somewhat one-sided application of ceramic photography. Grune, ten years ago, was the first to take negatives of drawings of ornamental designs, from which he obtained a collodion positive; this was left in a gold bath until a gold picture was obtained; the collodion film was next transferred to the porcelain, which was then fired and glazed. Unfortunately, the inventor did not receive sufficient encouragement, and the process was therefore given up.

Woodbury's experiments in the formation of water-marks in paper have been attended with greater success. He obtained a carbon picture countersunk in the lights and raised in the shadows. From an impression in metal a sort of die was made, which, being pressed upon paper, gave a water-mark.

Werner and Schumann, in Berlin, have, in this manner, printed not only portraits and landscapes, but also designs of all kinds as water-marks.

Lately, photography has entered into the working of metals. Steel seals are finished by means of light, the art of production being a kind of etching. Steel plates are coated with asphalt, and receive an impression from a negative upon which the design has been obtained; they are developed with turpentine, and the plates are then etched with acid, and a raised design is thus obtained upon the steel. The stamp is then hardened, and it is easy to obtain impressions upon metal from it by heavy pressure, the ornament being a metallic intaglio similar to an engraved plate. Falk, of Berlin, works in this manner upon thin copper bronze plates, and these, being bent into cylindrical or spherical forms, are made into lampstands and other things for which there is a steady sale in Germany.

Trials have been made to simplify this process by taking a lithographic or carbon transfer directly upon the metal, and then etching; the shadows, preserving their relative gradation in the drawing, remain in relief by etching.

An extensive use of photography is made in the ornamentation of glass by means of the sand blast. It is an extraordary fact that beautiful positives on glass, made by the carbon process, have found little favor with the public. Even the window transparencies, produced with the help of the Woodburytype, by Goupil & Co., in Paris, found no sale, although they did not fail for want of strenuous exertions on the part of the inventor.

The carbon transfers now serve as masks in the grinding of glass by the sand blast machine, all exposed parts of the picture being rendered matt by the blown sand, those protected by the carbon film remaining transparent.

For the more common work of this kind the carbon transfer is certainly too costly, and printed pattern or lines are employed; but for intricate drawings, which cannot be well printed, photography must be used. In the Vienna exhibition the inventor of the sand-blast machine showed some admirable specimens thus produced. These were then rare, and none could be obtained, even from the inventor; but now they can be had in Berlin and elsewhere.

These are only a few examples of the uses of photography in the industrial arts, which, in course of time, will show a more extensive development.—*Photographische Notizen.*

THE LARGEST SHEETS OF PLATE GLASS.

MR. C. COLNE's report on glass at the Paris Exhibition mentions the following remarkable plates, the product of the French factories named:

	Pounds.
St. Gobain; 1 plate 21·15 ft. x 13·48=285·10 ft., white, 7·16 in.	1,573
St. Gobain; 1 plate 17·90 ft. x 9·94=117·92 ft. silvered,	770
Jeumont; 1 plate 17·81 ft. x 11·51=205 ft., white.	1,100
Jeumont; 1 plate 17·22 ft. x 10·82=182·12 ft., silvered,	770
Aniche; 1 plate 15·76 ft. x 10·43=164·38 ft., white.	600
Aniche; 1 plate 14·76 ft. x 9·05=132·58 ft., silvered.	550

The St. Gobain Works furnished a number of mirrors to the new Grand Opera of Paris; among others one 21·29 x 9·67 feet; others from 45·12 to 52·48 feet long.

THE Durham (England) County police have nickel-plated handcuffs. A scientific contemparary says the result of the plating is vary beautiful, "and may perhaps be allowed to have a certain effect of silver guilt."

A NEW AIR THERMOMETER.

THE employment of air thermometers has been limited to great researches and to extraordinary cases; but it will be advantageous to introduce into the daily practice of our laboratories an instrument which, being the most exact, connects with an exquisite sensibility another valuable quality, viz., that of establishing an equilibrium with the medium in which it is placed. For this purpose, it will be necessary to simplify its construction, and facilitate its management, rendering its indications independent of the atmospheric pressure in such a manner that the observer will be able to read off the temperature directly instead of by calculation as heretofore. Mr. Jolly, Professor of the University of Munich, has already made the above mentioned proposition, but his thermometer is cumbersome and difficult to manage, because it requires the calculation of the temperature by deducing it from the observed atmospheric pressure. Mr. A. Witz has since made a new improvement which renders the thermometer much more simple and less expensive. He uses a kind of Leslie thermometer, of which one of the glass globes which contain air is kept at a constant temperature; the indications of the instrument are, therefore, absolute, and the tube in which the liquid rises may be graduated.

The great difficulty of the problem was to find a thermic regulator by which the glass globe could be kept at a fixed temperature. This has been accomplished in the following manner by Mr. Witz: He introduces into the globe a very fine platina wire rolled up in a spiral; this forms a part of a circuit which is closed by a mercurial column, the latter being movable in the curved part of an alcohol thermometer which is analogous to that of Six and Bellani. The indications of the latter are dependent upon the dilatations of the alcohol in the reservoir and partake of the temperature of the inclosure. One of the extremities of the mercurial column is always in contact with the platina wire, while the other opens and closes the circuit in recoiling and advancing. At the moment when the temperature falls below a certain point the circuit is closed, the current passes and the wire is heated; then the temperature rises again and the current is interrupted. When the fixed temperature of the regulator surpasses by about 10° C. that of the exterior air, a continual antagonism between the exterior action and that of the regulator is produced, resulting in an oscillation of temperature, the amplitude of which is not greater than 1° C. The constancy is, therefore, guaranteed if a source of electricity can always be obtained which is not polarized. Such a source of electricity Mr. Witz has discovered in the pile of Poggendorff, which, being immersed in bichromate of potassium, has a tension, quantity, and constancy which are exceedingly well adapted for the purpose. When care is taken every day to renew a small quantity of the acidulated water, which becomes green in consequence of the formation of sulphate of chrome, and if from time to time a new crystal of bichromate is put into the porous vessel, then two elements of Poggendorff's pile will be sufficient to keep the regulator at a temperature of 29·5 C. for a long series of days, the number of which Mr. Witz has not, as yet, been able to determine.

These are the principal outlines of the new thermometer. The degrees are read off from a portion of the tube which is inclined about 15° towards the horizon; the manometric liquid consists of almond oil colored by means of alkanet. The thermometer is, therefore, very sensitive, and one degree corresponds to a length of 0·020 to 0·030 meter (0·79 to 1·18 inches). Being at the same time very little cumbersome it may be used as a thermograph by employing photography for the registration of the movement of the liquid. The different forms which can be given to the thermoscopic globe render this thermometer appropriate for many different purposes, especially for measuring the temperature in physiological and medicinal observations. By the employment of a capillary tube of silver it may be used for the thermometrical examination of those parts of the body the most difficult of access. This thermometer becomes a barometer by leaving the thermoscopic globe away; in this case the liquid rises by the action of the barometric pressure and indicates this pressure automatically. The instrument might, therefore, be called a *thermobarograph.*

PHYSICS WITHOUT APPARATUS.

TAKE a sheet of paper, and form it into one of those small rectangular boxes such as are often made by school children. Suspend this to a horizontal wooden rod by means of threads attached to the corners; fill it with water; and under it

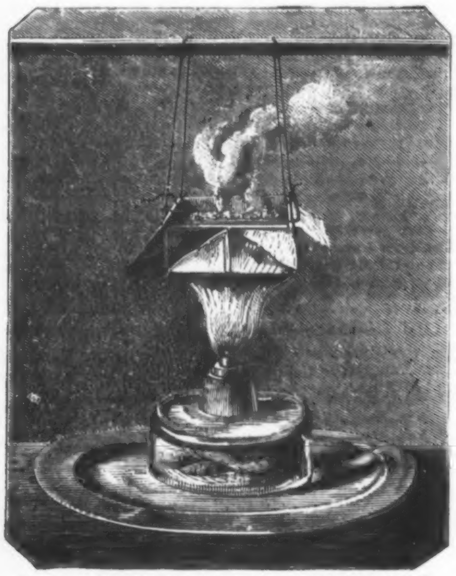


FIG. 1.—WATER BOILED IN A PAPER BOX.

place a spirit lamp having a pretty wide wick. Do not be afraid of burning the paper, but boldly light the lamp, and in the space of from five to ten minutes you will see the water begin to boil and give off an abundance of steam. The paper will not be even scorched, for the whole heat of

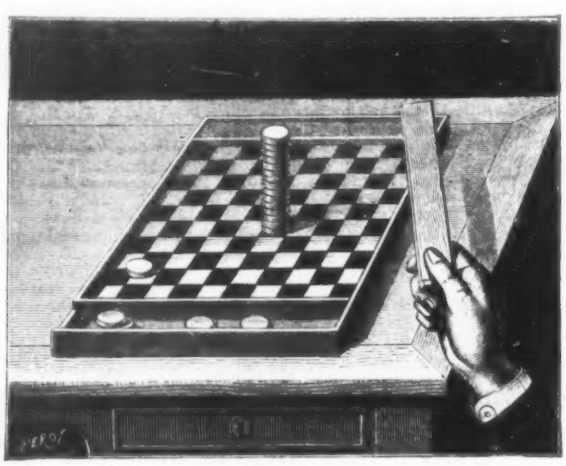


FIG. 2.—EXPERIMENT ON THE COLLISION OF SOLIDS.

the flame will have merely traversed its substance to be absorbed by the water and to convert it into vapor.

This experiment, which we have performed exactly as represented in Fig. 1, is still more curious than those of the melting of tin in a playing card, and of incandescent coal in

FIG. 3.—EXPERIMENT ON INERTIA.

contact with muslin stretched over a piece of metal, described in a former article. It forms a very neat complement to these, and requires no special apparatus. A similar experiment may be performed with an empty egg shell. When supported by an iron wire ring, this improvised vessel serves very well for boiling water in. Some experiments relating to collision between solid bodies have been described in a preceding article, but we may now complement them with the following additional ones:

The flexible stalk of almost any plant may be cut in twain by means of a quick horizontal blow given with a switch.

FIG. 4.—DECANTER LIFTED BY A STRAW.

If a lot of draughts be piled up on a draught board, any one of the draughts near the base of the pile may be easily knocked out, without disturbing those above it, by striking it smartly with one of the slides which close the boxes at the ends of the board (Fig. 2). The *ricochettings* observed when flat stones or shells are thrown so as to skim the surface of water belong to the same category of phenomena. It is perhaps well to remark besides, that when the velocity is very great any body, although soft, may indent another much harder body with which it comes in contact. Thus it

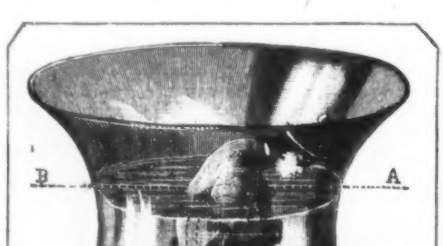


FIG. 5.—TANTALUS' CUP.

is that a pine board is perforated by a candle shot from a gun at a short distance.

Fig. 3 represents an amusing experiment which, like the breaking of a stick resting on two goblets, is referable to the principle of inertia. A ten cent piece is laid on a table, which is covered with a cloth or napkin, and over it is inverted a goblet, the edges of which rest on two twenty-five cent pieces, as shown in the engraving. Thus arranged, the question is how to make the ten cent piece issue from beneath the goblet without touching the latter or sliding an object from under it. To succeed in doing this it is merely

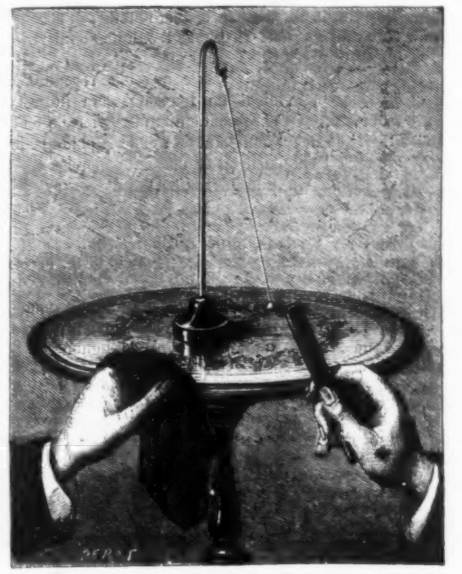


FIG. 6.—EXPERIMENT ON ELECTRICAL ATTRACTION.

necessary to scratch the table cloth or napkin with the nail of the forefinger close to the goblet; when, through the elasticity of the fibers of the fabric, motion is transmitted to the ten cent piece, which, in consequence of its inertia, begins to move towards the finger and escapes of itself from its prison.

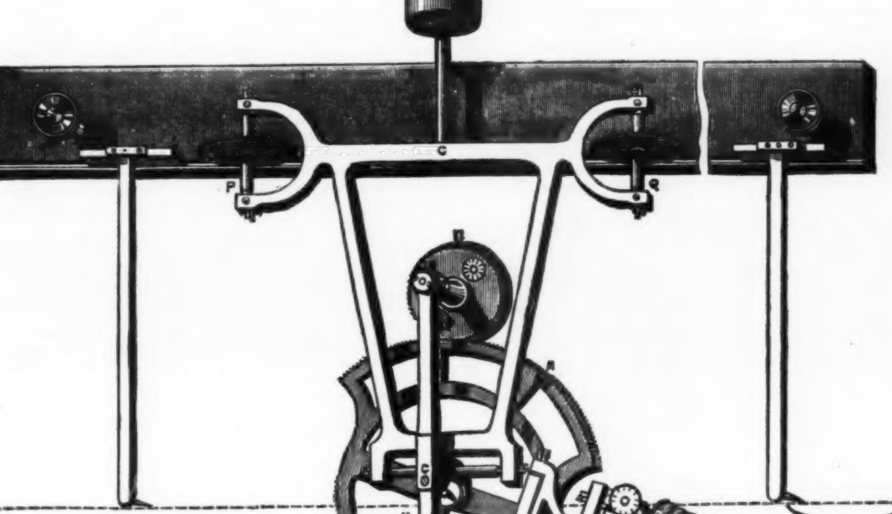
If it be desired to show the principle of the lever, a decanter may be lifted by means of a straw. The straw should be bent so that it forms a sharp angle, the shorter arm being nearly as long as the cylindrical portion of the decanter. It is afterwards arranged as shown in Fig. 4. It is necessary to make use of straws that are quite stiff and free from imperfections. Experiments relating to hydrostatics and to the flow of liquids may likewise be easily performed by means of small and simple apparatus. Up to the present we have said nothing about the siphon, so we will show it now under the curious form which is known as *Tantalus' cup.* A figure carved out of wood is fixed in the center of a glass vessel in the attitude of a person who is desirous of taking a drink. If water be poured gradually into the vessel it will be found impossible to cause its level to rise above the horizontal line A B (Fig. 5), and unfortunate Tantalus sees the water always just below the reach of his lips. This phenomenon is due to a siphon concealed within the figure, and the longer leg of which, passing through the foot of the vessel, traverses a table on which the latter stands. When the level of the water rises to A B, the submerged siphon (represented by dotted lines in the engraving) takes it up, and the liquid flows out under the table at C. No portion of the science of physics is so difficult that it cannot be shown and explained without apparatus; and even the study of electricity can be prosecuted in the same simple way. Rub a stick of sealing-wax, for example, with a piece of cloth, and then bring it near small bits of paper; the latter will be at once attracted by the electricity developed. Any one having a small amount of skill can easily construct a little pendulum like that represented in Fig. 6, and which consists of a silk thread suspended from a wired standard and having a cork ball attached to its lower extremity. If a piece of sealing-wax be rubbed with dry flannel and presented to the ball the latter will be attracted, and then after a momentary adhesion it will be repelled.

This serves very well to exhibit electrical attraction; but how shall we proceed to obtain the electric spark? All we shall need will be a simple sheet of paper. A large sized sheet of thick drawing paper is taken, strongly heated, and laid on a wooden table. It is then rubbed with the dry hand or a piece of flannel until it adheres to the table. A bunch of keys is now laid in the middle of the paper, and the latter is raised up by two of its corners. If at this moment some one presents his knuckle to the bunch of keys he will draw from it a brilliant spark. If the weather be very dry, and if the paper has been well heated several times, the spark may attain a length of over half an inch. A spark may also be obtained by rubbing a glass tube with a piece of silk and approaching the knuckle to it. The human body may also be electrically excited, so as to yield a spark, by rapid sliding over a carpet, and gas may be lighted by the spark so produced. It is on this principle that gas in certain manufactories is instantaneously lighted throughout the whole establishment by electricity developed by the friction of the running machinery.

MECHANICAL INTEGRATOR.

THE object of this instrument is to find the area, the statical moment, and the moment of inertia of any closed curve, by simply tracing out the curve with a pointer, the machine doing all the rest, and the results being read off directly from it without any trouble of calculation. The principle of it will be best understood by considering it as performing one operation only, instead of three together. Let us then consider a pointer, F, in the opposite engraving, rigidly attached to a horizontal circle. This circle is free to turn upon its center, and its center is free to move either way along a fixed straight line or axis, X X. To this circle is geared another horizontal circle, which moves along with it, so that the line of center is always at the same angle to the axis. On a radius of this second circle, as an axle, is mounted a little rolling wheel, Y, which is connected with a counter. This wheel turns when the second circle rotates, and records the space it turns through; but the motion in the direction of the axle simply gives rise to slipping, which is unrecorded. We thus obtain an integral of one component only of the motion. In what absolute direction

the resolution, of which one component only is thus integrated, shall take place, is settled by the extent of rotation of the second wheel, which is proportional to the extent to which the first wheel has been made to rotate by the pointer attached to it. Let us suppose the initial position of the pointer to be in the fixed line along which the center of the first circle moves. Then, as it traces out any given curve, there will be two motions to consider. First, the angular motion about the center, and, secondly, the linear displacement of the center. Let the angular motion be θ, so that if $n : 1$ be the ratio of the radii of the first and second circles



THE AMSLER-LAFFON INTEGRATOR.

to one another, the quantity of rotation of the second circle —which we may call φ—will be

$$\varphi = n\theta + a$$

a being an arbitrary constant dependent on the initial position of the second wheel. When the pointer goes all round any closed curve, which does not contain the center of the first circle, this measurement comes to nothing, for the angular movement is exactly the same backward as forward. The term of the integral, due to the rotation about the center, thus disappears altogether when we measure a closed contour, and may, therefore, be left out of account. The angle, φ, however, settled the direction of resolution of which the component is measured by the instrument, when there is linear motion of the center. The rolling wheel evidently records a constant multiple of

$$-d\,x \cos.\ \varphi$$

where $d\,x$ represents the movement of the machine parallel to the axis, for any fixed value of θ or φ. The complete record taken by the rolling wheel is thus

$$-\int d\,x \cos.\ \varphi \text{ or}$$

$$-\int d\,x \cos.\ (n\theta + a)$$

taken over the whole area of the curve. This has to be multiplied by a numerical factor depending on the size of the instrument and the proportion of its parts. We have next to transform this to rectangular co-ordinates. Taking x as the co-ordinate along the axis, the ordinate y is always proportionate to sin. θ, and all that we have to do is to choose a, so as to enable us to express cos. $(n\theta + a)$ in terms of sin. θ, for the value of n actually used in the particular machine. This is nothing more than the ratio of the diameters of the two circles, and is the same as the velocity ratio. In Amsler's machine there are two such secondary circles, with the values $n = 2$, $n = 3$.

When $n = 2$, taking $a = 0$ gives $\cos.\ 2\theta = 1-2\ (\sin.\ \theta)^2$

$$= 1-2\frac{y^2}{k^2}$$

The difference between two readings of the rolling-wheel counter, therefore, gives us a quantity always proportionate to

$$\int y^2\,d\,x,$$

since the term $\int d\,x$ disappears for the closed contour. This gives the statical moment.

When $n = 3$, taking $a = -\frac{\pi}{2}$ gives $\cos.\ (3\theta - \frac{\pi}{2}) =$

$$\sin.\ 3\theta = 3\,(\sin.\ \theta)^3 - 4\sin.\ \theta = 3\frac{y^3}{k^3} - 4\frac{y}{k}$$

The reading of the rolling wheel, therefore, gives the difference between the moment of inertia and a fixed multiple of the area. When the area is known, the moment of inertia is known by mere subtraction. This subtraction is not performed by the machine, but is left to the calculator. The area might be obtained in a similar way by making $n = 1$,

$$\text{and } a = -\frac{\pi}{2}, \text{ which gives}$$

$$\cos.\left(\theta - \frac{\pi}{2}\right) = \sin.\ \theta = \frac{y}{k};$$

but it is much simpler to fix the rolling wheel, which records this, directly on the bar carrying the pointer, instead of using a second equal circle, which would only give the same record in an opposite direction. Observe, that altering the sign merely means reversing the way in which the counter is figured. It is also to be noted that when $\theta = 0$, $\varphi = a$, since, as we have seen, a is to be taken as $-\frac{1}{2}\pi$ for the area and moment of inertia, we see that the initial position of the rolling wheels, when the pointer is on the axis, must be such that their axles shall be parallel to the bar carrying the pointer. Again, since $a = 0$ for the statical moment, the plane of the rolling wheel for it must be parallel to the axis, and the axle at right angles to it.

In Amsler's instrument the primary circle which we have mentioned is replaced by two arcs of circle—A H in the engraving—described about the same center with radii proportional to 2 and 3. There are two secondary circles, each with radius unity, one gearing with each of the two arcs, and so placed that the three centers are in a right line perpendicular to the axis. The whole machine is then confined to a rectilinear motion by a frame, C, running along a steel ruler parallel to the axis, L, a pair of wheels, P Q, running in a V-shaped groove in the ruler, being used instead of a mere sliding motion, which would give unnecessary and troublesome friction. G is a heavy steadying roller. K shows a bulb iron section being dealt with. K is an integrating wheel.

The author did not attempt to describe the various adjustments of the machine designed to secure easy and exact working, and to avoid lost time in the spur gear. It was sufficient to state that the arrangements are exceedingly well devised.—*The Engineer.*

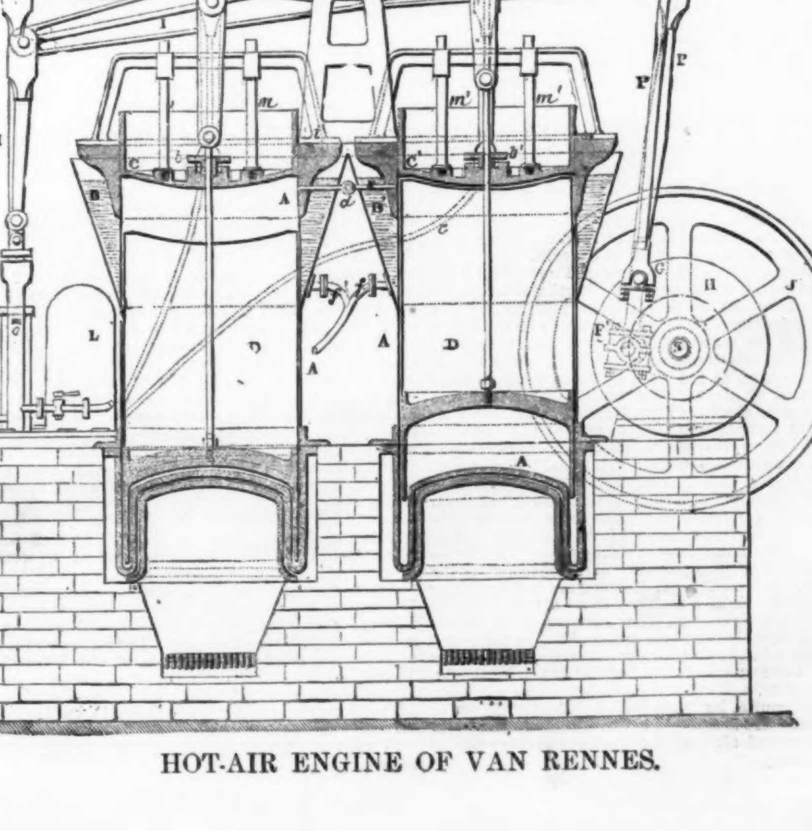
HOT-AIR ENGINE OF VAN RENNES.

THE hot air engine, with two cylinders, of Mr. Van Rennes, of Utrecht, Holland, has been known for two or three years, but the inventor has constructed, a short time ago, a somewhat modified and much improved machine for which he has received a patent and of which our picture is an illustration.

A, A', are two boilers, the lower parts of which, called fire boxes, are let into a piece of masonry or of cast iron, and are generally made of hard cast iron, while the upper part consists of sheet iron. These boilers are furnished with special pistons, C and C', which are open above, and which are rendered tight by means of a copper garniture or by some other device. These pistons are guided by the links, m and m', and are furnished in their center with openings, through which the ram of a movable piece, d d', passes, which has the shape of a bell where it touches the firebox. The upper part of each of the boilers is surrounded by an envelope in the shape of a hopper, in which cold water circulates for the purpose of refrigeration. Besides the two supports which serve as guides to the beams, m and m', the boilers have two other beams upon which the axes of the three balance beams, I, II, II'. The two pieces, D, D', are connected by means of cranks with the balance beam, I, which moves freely upon the shaft, S, *i. e.*, which oscillates in a metal socket of this shaft. The two pieces, C and C', are connected to the II, II', which are supported by the beam, S. The balance beam, II, is on each side somewhat longer than the balance beam, II', with which it works in unison. Its end at the right hand side is fastened by means of the link, P, to the crank of F, while the end at the left sets into motion the air pump, m, by means of the rod, N. The length of the balance beam, I, is equal to that of the balance beam, II. Its right extremity is connected by means of the link, P', with the knob, G, of the disk, H, while the left extremity moves the piston of the pump, O. The cranks, F' and G, form an angle of about 60°. J is a wheel moving around the axes, F, and K is a tube for the regulation of the machine, and connects the two boilers with each other, being furnished in the center with the tap, a.

The alternate moving up and down of the pistons, C and C', and of the balance beams, II, II', gives to the crank, F, and to the wheel, J, a rotation movement, and at each revolution the ascending and descending of the pieces, D and D', is caused by the links, G, P', and I. In our drawing, the pistons, C and C', are shown in their medium position. The piece, D, has not quite reached its lowest position, corresponding to a relative position of the knobs, F and G, while the piece, D', has not yet reached its highest position.

When the fireboxes are sufficiently heated the wheel, J, is set into motion and turned until the piston, C', has reached its extreme height, while the piston, C, has descended as far as possible. At this time the piece, D, has already completed a part of its ascending course, and nearly all the air contained in the boiler, A, has been pressed toward the sides



HOT-AIR ENGINE OF VAN RENNES.

of the firebox, where it is strongly heated and dilated, causing thereby the ascent of the piston, C. By means of the motion of the balance beams, II, II', and I, the piston, C', arrives at its lowest position, and the piece, D', having also reached its lowest point, commences to reascend. The relative position of the pistons, C' and D', is now exactly the same as that which was before occupied by the pistons, C and D, and the air contained in the cylinder, A', follows a similar course to that described for the cylinder, A. Each hindering counter pressure upon the descending piston is sufficiently avoided because the upper parts of the boiler are surrounded by cold water, which refrigerates the air contained in them.

The water which serves for the purpose of refrigeration is continually renewed by the action of the pump, O, which is worked by the balance beam, I. This pump sucks in the cold water through a pipe which is connected with the tubulure, e, and leads it through the pipes, f, f', and f'', into the hopper shaped enveloper. The water which has been used flows off through pipes connected with their upper parts.

The boilers are furnished with two valves, b, b', which open inside, and which are, by means of the pipes, c, c', in communication with the chamber, L, containing compressed air. As soon as the pressure of the air is lower in the boilers, A, A', than in the chamber, L, air passes from there into the boilers. m is an air pump worked by means of the balance beam, II. This pump serves for introducing air into the chamber, L, and keeping this air in a constant state of pressure.

The pipes, c and c', are provided with taps, which are closed when the machine is at rest, and which are used in the following manner when the machine has to be started: One of the taps is opened, and the chamber, L, is thus brought into communication with the boiler, A'; when the crank shaft has described its first half revolution, the other tap is opened, and the machine is ready to work.

The machine is regulated as follows: The two boilers, A and A', are communicated by means of a tube, K, as above told; by opening or closing the tap, a, the boilers can be brought into communication or can be separated from each other.

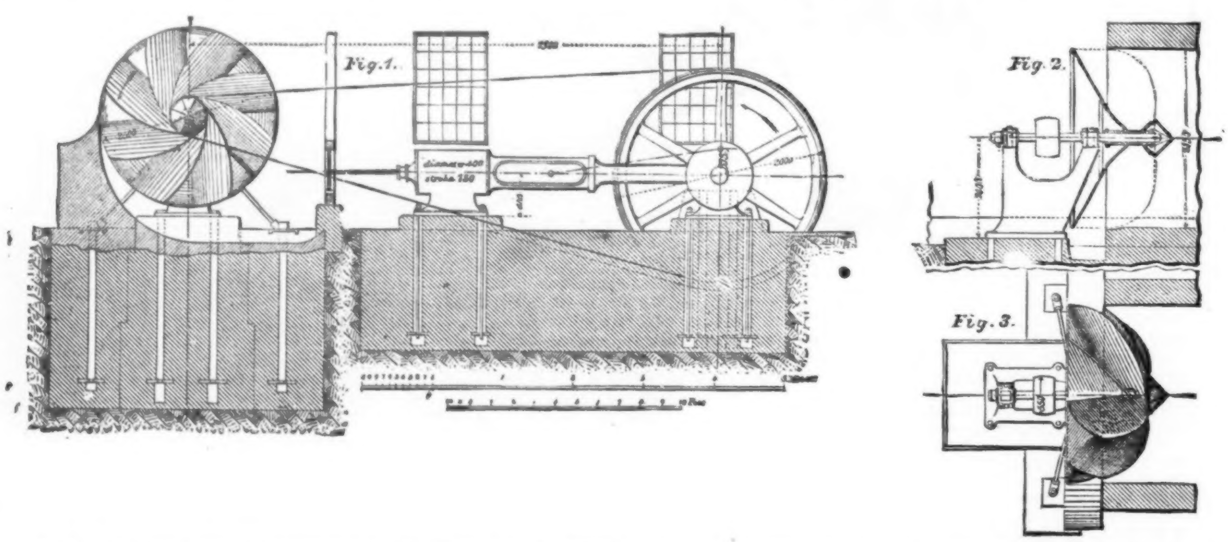
When the tap, a, is closed the machine works as indicated in our above description and develops its utmost power. But when the tap, a, is perfectly opened, so that the two boilers are in communication, the dilated air enters from the boiler in which it was originated into the other boiler, and opposes to the descending piston in that boiler a resistance which brings the motion of the machine finally to a rest.

This tap, a, may be fastened to a regulator, and the regulation of the machine will thus be established automatically. If only the half-power of the machine is desired one of the two boilers can be put out of use by detaching one of the pistons and unhooking the cranks.

PELZER'S SCREW VENTILATOR.

WE illustrate an exhausting ventilator, designed by Mr. F. Pelzer, and of which several specimens are shown at the Dusseldorf Exhibition by Messrs. Petry & Hecking, of Dortmund.

As will be seen from the perspective view, the ventilator is mounted upon an overhanging shaft running in two bearings, which are cast in one piece with a solid base. The ventilating screw or propeller consists of three parts: a flat cone of the maximum diameter of the ventilator forms the back, a more acute cone being placed in front, and a series of eight wings, equally pitched, are set spirally on the larger cone. All these parts are made of sheet iron, except the boss to which the two cones are fixed, as shown in Fig. 3. The wings are riveted to the cone by means of angle irons and are stiffened by stays. This fan is placed with the front within the air shaft (see Figs. 2 and 3), and is driven at a speed varying according to its size; fans of 4 ft. diameter have a speed of 700 revolutions per minute, while the largest sizes of 10 ft. diameter run at 300 revolutions. The results obtained with fans of this type in various mines in Rhenish Prussia and Westphalia, where a number of them have been at work for a considerable time, are said to be very satisfactory, and the ventilators are claimed to be much more effective than the Guibal fan. They certainly possess the advantage over the latter of being smaller and less costly for the same capacity. Messrs. Petry & Hecking are building these ventilators up to 10 ft. in diameter for an air shaft of 48 square feet area; and this size, when running at 300 revolutions, is stated to produce an exhaustion of $2\frac{3}{4}$ in. water and remove 120,000 cubic feet of air per minute. Fig. 1 shows the mode of driving a fan direct by belting from the fly-wheel of an engine, and in consequence of the air not being diverted in its course, but only spread radially, the power for driving these fans is asserted by the makers to be less for the same volume of air than that required to drive Guibal fans.—*Engineering.*



PELZER'S CENTRIFUGAL SCREW VENTILATOR AT THE DUSSELDORF EXHIBITION.

COMPRESSING STEEL.

ON THE STEEL-COMPRESSING ARRANGEMENTS AT THE BARROW WORKS.*

By Mr. ALFRED DAVIS, of London.

THE unsoundness of steel castings, particularly in the case of ingots made by the Bessemer or Siemens-Martin process, has given manufacturers considerable trouble, and occasions much waste of material.

A good deal has been stated and written of late as to the cause of this unsoundness, which occurs principally at the upper end of the ingot; but it appears now to be pretty generally conceded that the defects proceed from two distinct causes: First, the existence of gases, generated at the point of transition from the fluid to the solid state, which are imprisoned in the form of bubbles when the surrounding metal becomes solid; and secondly, the existence of spaces formed by the natural contraction of the metal in cooling, by reason of the outer skin first becoming solid and refusing to follow up the interior portion of the ingot, which subsequently cools, and consequently occupies a smaller space.

Various systems, designed to cure this evil, have already been discussed before this institution. The system, that of compressing fluid steel by the direct application of high-pressure steam, has recently been adopted by the Barrow Hematite Steel Works, and by Messrs. Bolckow, Vaughan & Co., and has the merit of simplicity combined with efficiency. The arrangements adopted for the purpose are founded upon those used by Mr. H. R. Jones, of the Edgar Thomson Steel Works, Pittsburg, U. S., where the system has been worked for some years.

The exact plan in operation at the Edgar Thomson Steel Works is shown by the model (see *Engineering*, vol. xxviii., pages 84 and 85).

A high-pressure steam boiler is provided, and communicates with a receiver, which is attached to the side of the ingot crane, and which is furnished with a row of cocks corresponding with the number of ingot moulds. From these cocks strong India-rubber pipes convey the steam to the ingot moulds, which are arranged in the arc of a circle round the ladle crane. The metal from the ladle is poured through a loose pouring cup, which rests on a conical seat at the top of the ingot mould. As soon as the pouring is finished this cup is removed, and a lid, having the steam pipe ready coupled to it, is placed on the top of the mould and secured to it by a steel cotter. The cock on the receiver is then opened, and the steam allowed to act upon the metal until it has completely set. The result of this pressure is to make the ingot sensibly shorter than when cast in the ordinary manner, the difference, according to experiments made at the Edgar Thomson Works, being from $1\frac{1}{2}$ in. to 2 in. in a 5 ft. or 6 ft. ingot. The ingots, when cold, are perfectly level at the top, and there is no porous head requiring to be cut off.

The arrangements adopted by the Barrow Steel Company differ somewhat from those in operation at the Edgar Thomson Works. These arrangements require only a very brief explanation.

The ingot moulds, which are of similar construction to those used by the Edgar Thomson Company, are placed in a row, within a dock or siding, the center line of which runs to the center of the pit. The metal flows from the ladle into a trough mounted upon wheels, and provided with runners at points corresponding with the centers of the ingot moulds when the trough is in position. This trough runs upon rails, placed on either side of the row of ingot moulds, and can readily be removed after the moulds are charged. Each mould is provided with a steam-tight cover, having a wrought-iron pipe attached to it, furnished with a stopcock. This pipe communicates at right angles with the main steam pipe, which runs parallel with the side of the dock. The junction of the branch steam pipes with the main is formed by means of a cast-iron sleeve piece, with stuffing boxes, to enable the covers, with their respective cocks and pipes, to be thrown back out of the way when not in use.

The boiler for supplying the steam has been constructed by Messrs. Daniel Adamson & Co. It is 3 ft. 6 in. in diameter and 9 ft. high, and is intended to be worked at a pressure of 200 lb. per square inch.

Another arrangement proposed has not yet been put in practice; but the author believes that it has some advantages over other plans, and that it will prove an efficient method of applying the steam. The ingot moulds are fixed in position in the same manner as at the Edgar Thomson Works, but the method of securing the bottom joint of the mould is somewhat different. In one form of joint suitable for both the lid and base of the mould, V-shaped grooves are turned in the faces of the metal, care being taken that the diameters of the two grooves forming the joint are exactly equal. A ring of soft copper wire is then inserted and the two parts well keyed up with cotters, as before described.

The main pipe for supplying the steam follows the curve of the pit, about 12 in. from the side and 18 in. below the surface of the ground. The branch steam pipe is of copper, coiled to give elasticity, and has at one end the lid of the mould and at the other a stop-valve. The stop-valve is attached to a hollow sleeve, revolving on the main steam pipe, and is kept tight by means of stuffing boxes. When not in use, the copper coil, lid, and coupling can be thrown back, and fall into a pit made for the purpose. This pit is covered over with an iron plate hinged at one side. No doubt other plans for applying steam pressure could be suggested, and various modifications will be necessary to suit different conditions of working.

At the Cambria Steel Works in Pennsylvania an attempt was made two or three years ago to inject water through the cover of the ingot mould after the metal had been poured. The heat of the molten steel, of course, generated steam, which acted as a compressing medium, a safety valve being provided and loaded to the pressure required. The disadvantages of this system, as compared with that now described, are sufficiently obvious, the complication of parts and the danger from explosions being very great.

The results obtained by the process of casting ingots under steam compression are highly satisfactory. Not merely is the ingot perfectly sound, but the action of the steam is such as to enable the men to work it earlier and in a hotter state than with the ordinary method, so that there is an appreciable increase in the output. The presence of the steam also acts beneficially on the sides of the mould and causes it to last longer.

The pressure necessary to produce a perfectly sound ingot will depend upon the quality of steel to which it is applied. At the Edgar Thomson Works it is found that for ordinary rail metal 100 lb. per square inch is sufficient. But for milder steel a higher pressure is needed; and since experience has proved that steam is readily dealt with at very high pressures, there does not appear to be any reason why 1,000 lb. or 1,500 lb. per square inch should not be applied if required. It is only a question of giving sufficient strength to those parts which are exposed to the pressure. As a matter of fact, the boilers designed by Mr. Loftus Perkins will carry a steam pressure of 2,000 lb. per square inch with perfect safety. The question of making tight joints between the ingot moulds and covers with such high pressures is one of considerable importance; but there are several ways in which this difficulty may be overcome. In using steam at a very high pressure the size of the supply pipe may be considerably reduced and the mode of attachment greatly simplified; and since the amount of steam used is inconsiderable, the size of the boiler would be correspondingly small. As an alternative, in cases where high pressures are needed for the consolidation of fluid metals, the author proposes the use of compressed air. With this system a pressure up to 1,500 lb. or 2,000 lb. per square inch may be obtained without danger or difficulty, as is completely demonstrated by the torpedo practice at Woolwich, and by the experiments carried out by Colonel Beaumont, in connection with the use of compressed air for tramway locomotion.

The advantages of an elastic compressing medium in the consolidation of fluid metals, as compared with the hydraulic process, scarcely need to be dwelt upon. In applying hydraulic pressure a rigid piston is necessary; and the outer portions of the cooling mass (which are the first to set) must be crushed down, before the interior portions, which are still liquid, are reached by the pressure. A considerable amount of power is wasted in consequence. In addition the fluid metal is forced against the sides of the mould, and in a contrary direction to that which it naturally follows in the operation of cooling. With steam or compressed air the operation is reversed; as soon as contraction commences the entire ingot is surrounded by a uniform pressure, which continually follows up the natural contraction of the mass.

In conclusion, the author would suggest that the principle of elastic pressure, in connection with the consolidation of fluid metals, although at present applied to Bessemer ingots only, is well worth the consideration of those interested in the manufacture of all kinds of steel and iron castings, and particularly of heavy guns.

* A paper read before the Institution of Mechanical Engineers, at Barrow.

THE AGATE QUARRIES OF SAN LUIS OBISPO.

THE development of the extensive deposits of agate, at the head of Huasna Creek, twenty-five miles from San Luis Obispo, California, has lately been undertaken. The rock is interstratified with clay, and when dressed is said to be nearly translucent and very beautiful. The color varies; some parts being pure white, others of a pinkish tinge, others gray.

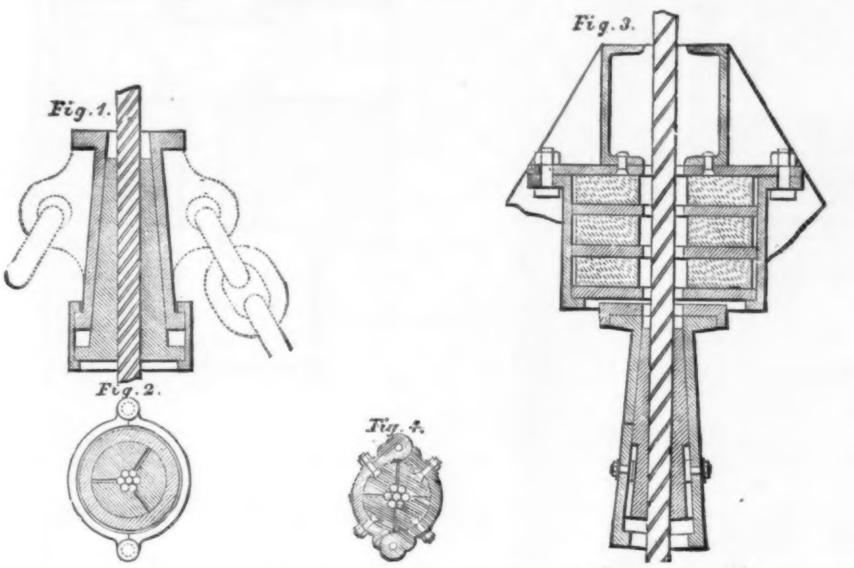
WIRE ROPE CONNECTIONS.

THE connections commonly in use for securing wire rope to hoist cages consist in either bending the end of the rope into a loop, putting an iron ring into it, and lashing or clamping the end against the side of the rope, or the end of the rope passes through a conical sleeve, and a tapered wedge is then driven in between the wires of the rope, forcing the latter against the sides of the sleeve, and thus firmly uniting the two, or the wires in the end of the rope are turned back, the rope being passed through a conical sleeve, and the space run in with lead. All these methods are applicable where the end of a rope is to be fastened to a cage; but in all cases this end is destroyed, and the two cannot be separated—for repairs, for instance—without renewing the mode of connection after the previous end has been cut off. In cases where, as it is at present not uncommonly the case, a continuous rope is used partly for the purpose of balancing the weight of the rope, partly for working with the same rope from different stages, the modes of connection above referred to are not suitable, and some other means of making the connection have to be employed. The principal conditions which a coupling for this purpose has to fulfill are: first, to form a safe and firm connection, and, secondly, one which in no way injures the wire rope, since an injured place in the middle of a rope cannot well be repaired. It is, moreover, desirable that this coupling should be capable of being easily and rapidly put into or out of operation. A coupling which fulfills these requirements, and has for some time been in practical use in Rhenish Prussia, is shown by its inventor, Mr. F. Baumann, at the Dusseldorf Exhibition, and we understand that it is already applied to a considerable extent in the Rhenish and Westphalian mining districts.

This coupling is shown in its simplest form in Figs. 1 and 2, from which it will be seen that it consists of an outer conical casing fixed to the cross bar of the cage. Through this casing the rope passes, it being held in position by three or more conical pieces exactly fitting the casing externally, and the windings of the rope internally. The weight of the cage will naturally exert a pressure on the rope which increases with the load. These fitting pieces are cast in white metal or brass round the rope, and the coupling has stood some of the severest tests; having been tried in one case with a ¾ in. rope, consisting of thirty wires, 0·1 in. in diameter, well greased, and the cage loaded till the rope broke about 10 ft. above the coupling under a load of 7½ tons; the place where the coupling had gripped the rope could not, after the oil had been wiped off, be found, showing that the rope does not in any way suffer, and that no slip had taken place.

A hinged ring connecting the fitting pieces with the casing prevents the coupling from disengaging when the cage sets off at the bottom. An arrangement of this construction has been in use at the Friedrichsthal mines for over a year, and has been weekly shunted about several times, but has up to the present given every satisfaction.

To entirely avoid the necessity of care in adjusting this coupling, which is indispensable in the arrangement above described, and to obtain a still more rapid disconnection, Mr. Baumann has designed the arrangement shown in Figs. 3 and 4. The packing pieces here consist of four pieces with dovetailed slots, into which fit the heads of four bolts. The casing outside is made in two pieces hinged together, and this cannot be closed over the rope until the "lay" of the rope thoroughly fits into the grooves. An India-rubber buffer is added to avoid the sudden shock on the rope. In steel ropes, suitably arranged to carry an electric cable inside, communication can easily be established between the cage and the engine room. This system certainly possesses great advantages where a continuous rope is used, but even for a single rope, where disconnecting is occasionally necessary, it is a very handy arrangement.—*Engineering.*



BAUMANN'S WIRE ROPE CONNECTION FOR MINING CAGES.

THE VILLE D'ORAN AND VILLE DE BONE.

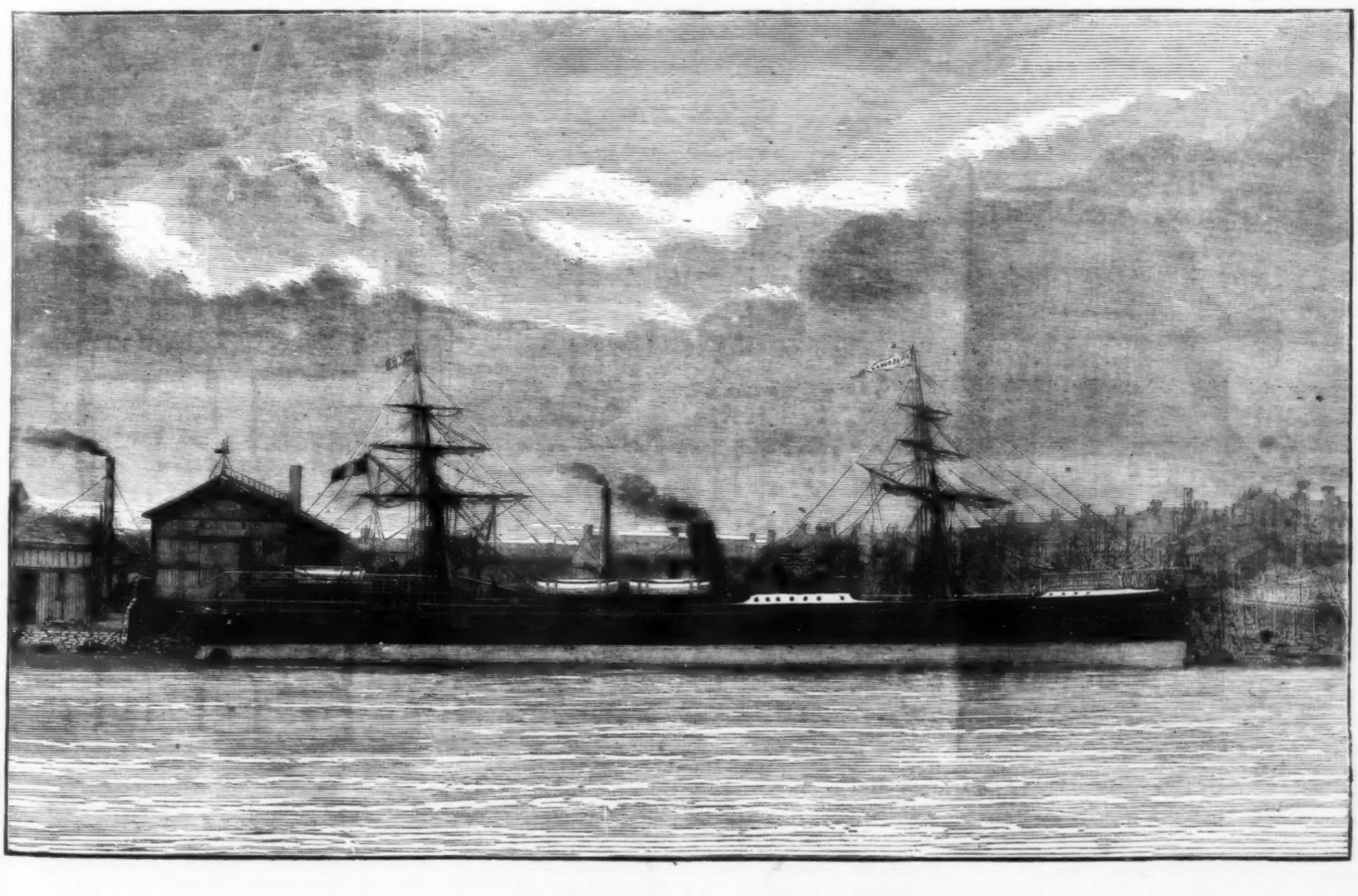
IN the autumn of last year the French Government solicited tenders for the postal service between Marseilles and the Colony of Algeria, with branch lines to certain ports in Spain. Hitherto this service had been performed by the Valery Company, but the lowest tender having been sent in by the Transatlantique Company, of Paris, the subvention was awarded to them. Under the circumstances the company found it necessary at once to procure fifteen steamers, and in fact they ordered a larger number than this, as they determined to carry their own coal from England to Marseilles, and also about the same time they contracted with the English Government to conduct the postal service between Malta and Syracuse.

It will be in the recollection of our readers that a great rise took place in the iron trade toward the close of last year, occasioned principally by an unexpected demand springing up from America, and the speculation which set in in consequence thereof; but we believe the ordering of all these steamers by the Transatlantique Company had also an important effect upon the market; not that fifteen steamers is any very large number for the extensive shipyards of Great Britain, but inasmuch as the service was to begin on the 1st July of this year, it was necessary that the vessels should be completed in England by the beginning of June, while the order was not finally placed with the builders until the middle or latter part of November; thus leaving not more than about seven months for their construction, and thus every builder was naturally very pressing for the delivery of the iron required to build them; this is a kind of pressure which always very much stiffens any market.

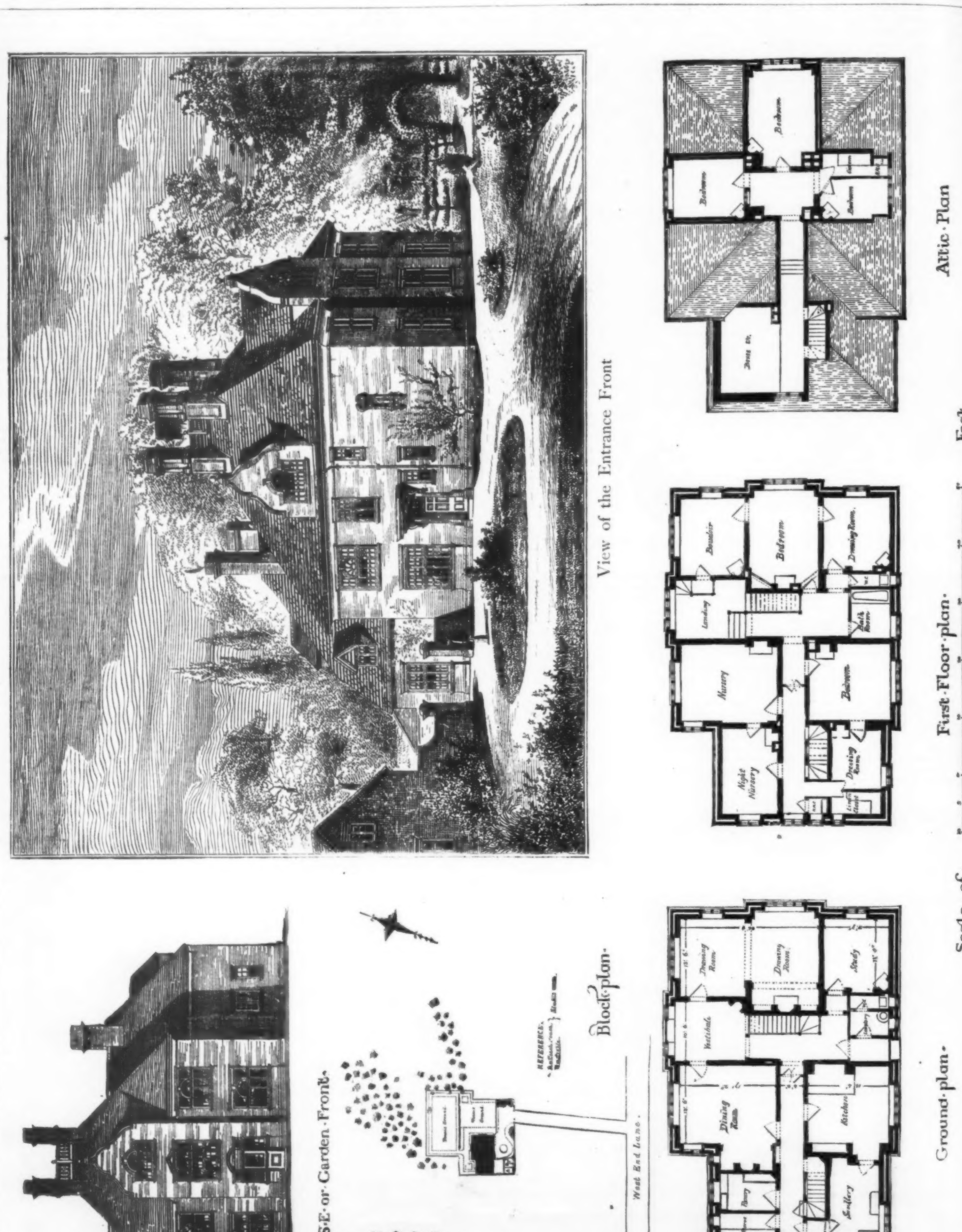
There was considerable soreness among builders in France that all these vessels were ordered in Great Britain; but, as a matter of fact, none of the French builders would undertake to deliver within the stipulated time, and their prices were, moreover, considerably higher. The English builders kept time so as to deliver half of the steamers within the date fixed for delivery, and the remainder with a delay of three or four weeks at the most, and this delay was mainly caused by the spurt in the iron trade and the pressure at the works at the beginning of the year above referred to. The vessels with which Messrs. Valery performed the service were of comparatively small dimensions, but the Transatlantique Company, considering that they have lines from Havre to New York, from St. Nazaire to the Gulf of Mexico, and from Marseilles to the West Indies, besides subsidiary lines, determined that at least ten of the new steamers should be adapted, not only as to dimensions, but also as to power and fittings, for transatlantic service.

We now proceed to give a description of two of these steamers, the Ville d'Oran and Ville de Bone, which were constructed by Messrs. Wigham, Richardson & Co., of the Neptune Engine and Shipbuilding Works, Newcastle-on-Tyne, and one of which we illustrate on this page.

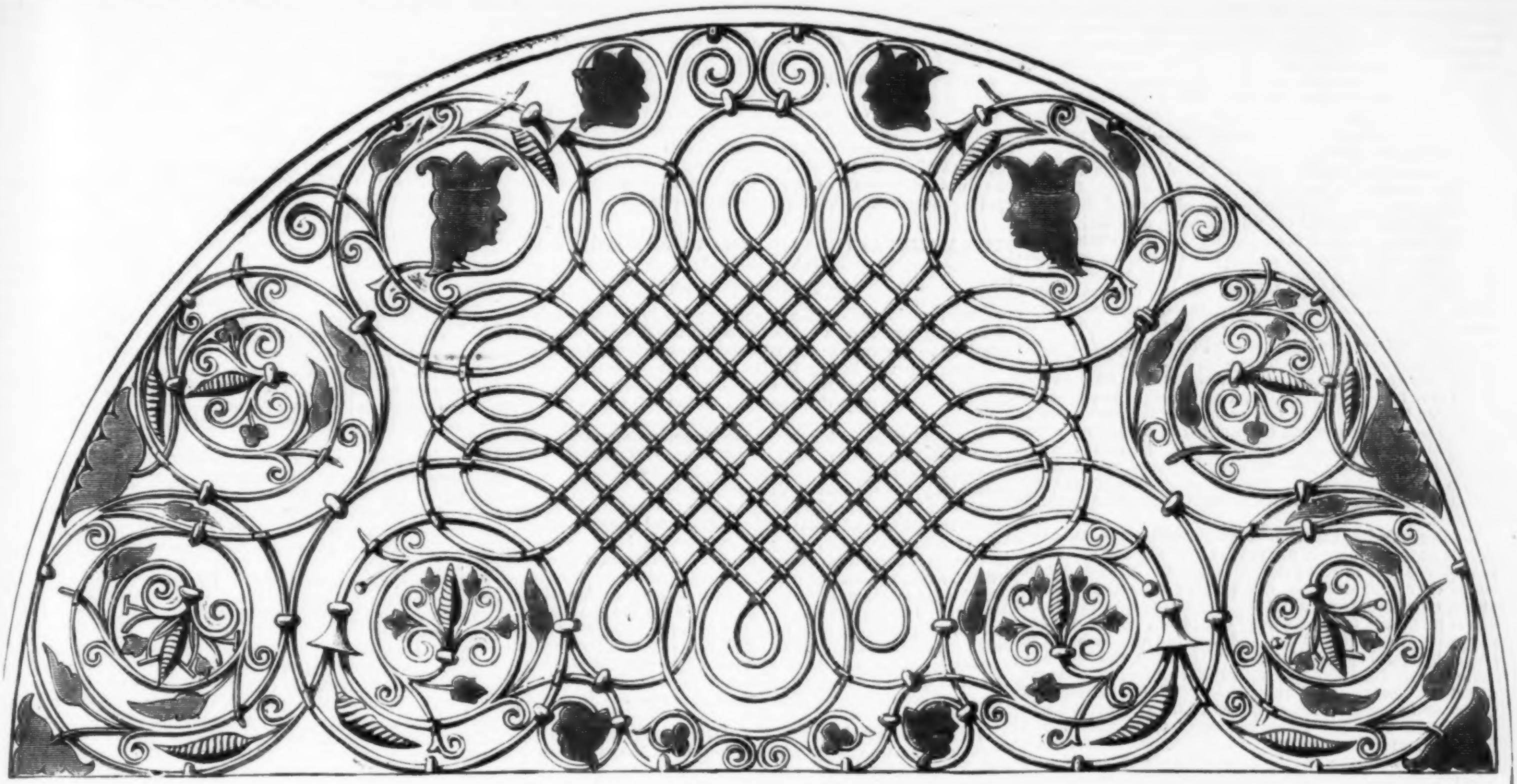
Length between perpendiculars, 313½ ft.; breadth of beam, 33½ ft.; depth, 25½ ft. They were built to the highest class at Veritas, but the company's specification provided for considerable increase of scantlings of irons, so as to give more longitudinal strength than required by the rules. A large deckhouse aft, which, as well as the other deckhouses amidships, is of iron, contains the first-class dining saloon. An iron turtle back covers in the forecastle to insure comfort during heavy seas. The passenger accommodation is for sixty first, fifty second, and forty third class passengers, and about 350 soldiers on the lower deck. The first-class dining saloon is a large and elegantly appointed room upon the main deck, the vestibule and smoking room are paneled in imitation of the library at Naworth Castle, but relieved by escallopette gilding. The centers of the panels are in Amboyna wood, the framing in rosewood. The walls of the saloon are of light-colored marble incised with gold, and pilasters of dark marble with red marble columns and gilded capitals, the whole being finished



THE VILLE D'ORAN AND VILLE DE BONE.



ARTISTS' HOMES, No. 5.—MR. BASIL CHAMPNEYS' HOUSE, "MANOR FARM," HAMPSTEAD.—BASIL CHAMPNEYS, ARCHITECT.



TOP OF DOORWAY IN WROUGHT AND HAMMERED IRON, FROM A HOUSE IN NUREMBERG; SIXTEENTH CENTURY WORK.—*From The Workshop.*

off with a gilded cornice. The ceiling is of white enamel, relieved with gold. The fittings are of the most elaborate character. The settees run round the two sides, and revolving chairs are between the tables. The piano and sideboards are made to match the framing, and every requisite is provided for the comfort and enjoyment of the passengers.

Especially are the lighting and ventilation of the saloon, and, indeed, of every other part of the ship, carefully attended to. Forward of and in close proximity to the saloon there is a pantry arranged for French requirements, while immediately aft there is a comfortable smoking room. The staterooms for the first-class passengers are provided with appliances for comfort to an extent not usual in English steamers. Over the house in which the saloon is placed there is a spacious promenade deck, carried out to the rail, thus forming a covered colonnade below. The second-class passengers are located in staterooms proportionately similar in character to the first-class. The dining saloon in this part of the ship extends right across the vessel. The accommodation for the captain and his officers is provided in deckhouses amidships. Corridors run right fore and aft throughout the vessels on both sides, but communication between the various classes can be stopped by means of iron water-tight doors in the bulkheads. Electric bells are fitted throughout. The baths are of solid marble. Ample accommodation is provided in the galleys for the *cuisine*. The pumping apparatus, in case of a serious leak, is most elaborate, and includes powerful centrifugal pumps and ejectors, besides the pumps attached to the main engine and numerous bilge pumps, both hand and worked by the winches.

The engines are of the inverted compound cylinder type with surface condensers. Diameter of the high-pressure cylinder, 42 in.; diameter of the low-pressure cylinder, 80 in.; stroke, 48 in.; indicated horse power, 2,100. There is an expansion valve on the back of the high-pressure valve, and the range of expansion is from 35 to 65 per cent. The high-pressure main valve is single-ported, but that for the low-pressure cylinder is double-ported, and it is kept in position on its face by two sets of springs, one set on each side. Both valves are fitted with balance cylinders, that for the low-pressure valve being 13 in. diameter, and for the high-pressure 9 in., fitted with Ramsbottom packing rings. A guide for the valve spindles is placed between the valve and the piston to relieve the latter from any guiding duty; guides are also provided for the lower ends of the spindles. Both cylinders, as well as the cylinder faces, are fitted with close-grained liners of cast iron; the former are secured at the bottom by bolted flanges, and at the top by a recess packed with asbestos and secured by plates and bolts. Both liners are arranged so as to form steam jackets.

The crank shaft is 15 in. diameter, the crank pin 18 in. long, the propeller shaft 15 in. diameter, and the tunnel shaft 14 in. diameter. The condenser is horizontal and parallel with the line of the keel, and has 4,000 ft. of cooling surface. The tinned brass tubes are ¾ in. diameter, swelled at one end for convenience of withdrawal, and secured in brass plates with screws and glands and cotton packing. The screw glands are flanged over on their outer ends to prevent the tubes moving endways, and to give a stronger bearing for the tools used in fitting them. The water is forced through the condenser by a Gwynne centrifugal pump, and for the purpose of keeping the feed-water as hot as possible the circulating water is passed through the upper nest of tubes first, and, returning through the lower rows, goes overboard through a separate discharge valve. The air pump is 31 in. diameter, with 28 in. stroke, and, as well as the feed and bilge pump, is worked by levers from the crosshead of the after engine. The air-pump foot valve is provided with a door for easy access for repairs. The hot well is fitted with overflow pipe overboard, and air pipe to the bilges and a glass water gauge.

A separate engine is fitted between the condenser end and the after bulkhead for turning the main engines in harbor when undergoing repairs. The reversing gear is hydraulic. The boilers are two in number, multitubular, double-ended, 13½ ft. diameter and 18½ ft. long. There are twelve furnaces in all, 3½ ft. diameter and 6½ ft. long. The tubes are 3¼ in. diameter, and a sufficient number of tubes ½ in. thick are screwed into both tube plates to form stays; no nuts are fitted, but the tubes are simply screwed into the plate and expanded. The safety valves are loaded with springs, with screw-easing gear worked from the engine room. There are separate small steam winches of novel design for heaving up the ashes. The service of water and steam all over the ships is of a most elaborate and costly description, and, in the opinion of some, so much apparatus may sooner or later lead to trouble.

The mail contract speed for these steamers is 12 knots, and the French Government requires a trial trip speed of 13½ knots. Under these circumstances, Mons. Audinet, the engineer-in-chief of the company, recommended that the steamers should be constructed for a 14 knot trial trip speed, and be stipulated for a consumption of not over 2 lb. of Welsh coal per indicated horse power per hour. As there was some rivalry among the different builders, it was a matter for serious consideration with Messrs. Wigham, Richardson & Co. whether they should extend the introduction of steam, put on a fine pitch screw of small area, and get a high speed on the trial. However, they determined with the full concurrence of the officials of the company to adopt the contrary course, and to aim principally at a low consumption, and to fit a screw of such an area as that it could always contend with head winds. They felt that this would in the long run be most satisfactory, and we believe their decision has been abundantly justified since the steamers have gone on to their station. It was in their option to use either best Welsh coal or Newcastle coal with an allowance of ten per cent. The latter, Cookson's Hartley, was used, and when running from 14 to 14½ knots, the stop valves full open the whole time, the coal burned was 1·517 lb. If an allowance be made for Newcastle coal, this brings the rate below 1½ lb. per hour, and is as low, or a lower rate of consumption than has yet been attained. The lines of the Ville de Bone and of the Ville d'Oran were drawn by Mr. Charles Christie, one of the partners in the firm.

The engines, with the exception of some special details, were designed by Mr. John Tweedy, the manager of the engine works. The cylinders and liners and some other castings were made by Sir W. G. Armstrong & Co., of their special iron. The whole of the work was carried out under the inspection and with the cordial assistance of M. Daymard, assisted by Messrs. Launey—father and son—over the ship, and M. Mignon over the engines.

The following extract from a letter recently received will show how these steamers are performing: "The Ville d'Oran is in port again back from her fourth trip. They are giving her far too much work to do. The captain says he is delighted with her. She runs splendidly, and so do the engines; they have never given the least bother. During the last run she went fifty-nine miles in 3 h. 30 min., *i. e.*, 16·8 knots per hour.—*The Engineer.*

ARTISTS' HOMES: NO. 5—MR. CHAMPNEYS' HOUSE, HAMPSTEAD.

MR. BASIL CHAMPNEYS' own house, which is now in course of erection, forms the subject of our Artists' Homes illustration opposite. In the planning of the house, the principal point observed by the architect has been an endeavor to follow the lines of houses erected during the last two centuries in making a continuous passage through the house, showing the garden beyond, and forming a vestibule which can be to some extent used as a room communicating with the garden grounds. Here this vestibule or garden room is divided from the staircase hall by a double arched opening, one of which openings communicates with a useful cupboard for tennis balls, bats, etc., next the fireplace and under the stairs. In the dining room the main parallelogram has been made serviceable to the fullest extent for table and chairs by the removal of the fireplace into a cosy recess instead of allowing it to project into the apartment in the more usual way, obstructing the room and diminishing the otherwise available space. A somewhat analogous arrangement appears in the drawing room, which is a fine apartment 24 ft. 8 in. long by 14 ft. wide, divided into two compartments by an arched opening, similar to that which spaces off the "Inglenook" fireplace, which is arranged ample enough for sitting in. A third sitting room, as a study, is planned near the entrance hall, and the kitchen with offices are nicely arranged on the N. E. side of the house. The plans readily show the building throughout, and thus leave little more here requiring description, while the elevation of the S. E., or garden front, and perspective view of the entrance elevation, complete our illustrations, in company with a general block-plan of the site and its surroundings. The main walls of the house are hollow in construction, having 4½ in. outside and 9 in. inside, the space between being 6 in., which unusual width is purposely arranged to give sufficient depth for the shutters to the windows, and thus prevent their projection into the room. In many of Mr. Champneys' buildings it has been observed that much point is made of the symmetrical planning of the chimneys, and the present occasion will illustrate a conspicuous instance of this rule. The idea is that all chimney-stacks should be kept within the outer walls and inside the house, for the better retention of all the fire heat possible, and to prevent a tendency to smoke, which all external built flues have in a more or less degree. From an artistic point of view it certainly may fairly be described as an anomaly that when a general design of a house suggests a studied symmetry, the chimneys, the most important features in the sky line, should crop up at haphazard, as it were, as if their existence or distribution were not of the least importance. Here at "Manor Farm" four boldly designed chimney stacks in cut brickwork form a central feature from every point of view, and inclose a Belvedere balcony from which the beauties of the prospect may be enjoyed, and this arrangement of the chimney stacks is arrived at by legitimate construction, and without the use of iron in any way. The materials used are red bricks for the walls, the cramps in the hollow parts being of galvanized iron. The roofs are covered with tiles, and the woodwork outside, like the cornice cove, is painted a dead white. The builders are Messrs. Bell & Sons, of Cambridge and Saffron Walden. A studio or office is arranged over the stables, seen on the left-hand side of our view, and the kitchen yard is cut off from the entrance garden by a brick wall and gates as shown.—*Building News.*

EXPERIMENT IN ACOUSTICS.

LAST Saturday, August 7, an interesting acoustical experiment took place in the premises of Mr. A. C. Engert, of the City Road, the object of which was to show how sound may be propagated and improved by the use of steel plates and wires. Last week we gave a *résumé* of Mr. Engert's plan, and we are now enabled to speak with more confidence of the method adopted, believing that the principle is capable of being developed and applied to the improvement of sound in buildings not properly planned for that purpose. With all our practical science and architectural progress, it seems almost impossible for our best architects to design a hall or a concert room that is fairly perfect as regards sound; even those who have set themselves to solve the problem, unhampered by other necessities, have failed in the attempt, as that great failure, in so many respects, the Albert Hall itself, affords a proof. The old adage is exemplified in this as in many other matters, that an ounce of fact is worth a ton of theory. Mr. Engert has been a student of the subject for forty years, and he seems to have tested every step by experiment. Those who visited the late Building Exhibition at the Agricultural Hall at Islington may remember the stall which this gentleman had fitted up, in which was placed a piano, having several steel plates hung behind it for the purpose of showing how the notes of the instrument were increased in volume and richness. Many who had the curiosity to enter the stall expressed some doubt about the matter, till it was clearly proved to them that the plates did really magnify the sound, and that the instrument played without their assistance was wanting in tone and richness. But this experiment was hardly practical in its results. People did not care to order a lot of rough steel plates straight off, to hang behind their costly drawing room

pianoforte. Since then, Mr. Engert has been busily engaged perfecting his theory, and he now has introduced an improvement in the shape of steel wires, which are less unsightly, and can be applied to rooms of all shapes. By the use of the plates or wires, artificial resonance is obtained, and further every sound becomes fuller and richer; the speaker finds he can use less voice to produce the same effect, and his efforts to make himself heard, being reduced, are rendered less harsh.

Now, architects usually endeavor to obtain this desirable result in a concert or lecture hall by using linings of wood, sounding boards, and reflectors; and pine wood is known to be a valuable material for this purpose, as sound travels in it four times quicker than in air; but unfortunately a well filled public room neutralizes the effect, for every individual becomes a damper, and deadens the sound. There are, also, the disturbing elements of architectural effect, breaks, recesses, columns, timber roofs, etc., to contend against, which cause return waves of sound to follow one another at different intervals, according to the distance and angle of the obstruction, and thus confusion of sound is the result. By the judicious use of drapery the after sound waves may be prevented or deadened; for it must be remembered the secret of causing sound to be heard clearly and distinctly is to prevent the repetition of sound waves from different distances, so that, in fact, the return waves should reach in a due time the original sound, and combine with it and re-enforce it as it were. Only by securing this simultaneous return of the sound waves can distinctness be obtained.

Mr. Engert's first experiment last Saturday was quite conclusive as to the value of steel plates in producing resonance. In a room about 18 ft. square a piano was placed, behind which were hung or fastened a number of vibrating steel plates, of gauges from 20 to 28, so placed that the sound waves might act freely between the plates. To assist this the plates are curved a little, and they are also fastened together by spiral steel springs. At their lower end they hang quite free, so that they take up any vibration in the air produced by a note. The wave thus confined between the plates, and repelled a large number of times, creates a repetition of the sound, or a combination of these repetitions is produced, adding to the volume and richness of the original note. Proof of the value of the steel plates was afforded when a young lady (Miss Rolfe, daughter of Mr. Engert's partner) played an air on the piano, and also when her sister accompanied her in singing. Though the instrument was rapidly played, each note was distinctly heard; the steel plates in fact, absorb the vibrations, and respond to the same sound. The thicker plates, as may be expected, favor the higher notes, and the thinner ones the lower notes.

The second experiment was made to show the effect of steel wires in distributing the sound. Those who were present accompanied the inventor to a large factory, where eight wires were stretched longitudinally at a height of 8 or 9 ft. from the floor. These were tightened to a certain tension by screws at one end, and fixed to hooks at the other end; across the wires were others, connected by spiral springs, while vertical wires fixed to the floor were passed through a space left open by the removal of one of the floor boards. These wires were behind the pianoforte, which stood near one end of the room of rectangular shape. After the audience had been distributed in different parts of the room, Mr. Engert made a few remarks, which were distinctly audible to every one. He next showed the effect of his speaking when his listeners were in an adjoining part of the factory without wires, and afterward the experiment was repeated, the visitors going upon the floor above, where four wires were longitudinally fixed in connection with the upright ones, which we have before described. The speaker remained below, and his remarks were distinctly heard above when the listeners stood between and below the wires, but at other parts of the loft he was inaudible. It may be explained thus: the wires absorb the vibrations of the voice, and convey it from one to another, by which means every word is distributed over the room with clearness. No after sound was audible, as the waves are broken by the wires, which take up the notes, and give them out again in every direction. The effect of the wires is to increase the speed of sound, to spread it over a larger space, and prevent the return of vibrations. For this purpose the wires must be tuned to the room, so as to enable them to take up the vibrations readily, and convey them. The inventor does not claim to magnify the sound by these means, but to convey and spread it with distinctness, and to prevent any echo or confusion that may exist in the room. The wires of different gauges, according to their length, are placed 2 or 3 ft. apart, and one or more layers of them, all connected, may be fixed at certain heights, which are regulated by experiment. The lower they are, the better effect they are said to produce. In a church a height of 15 ft. may be taken. The experiments were enlivened by some music and songs, every note of which was rendered distinct by the arrangement, so that one could enjoy music in any part of a large room no matter at what distance from the instrument. It must be remarked that Mr. Engert's system is not the plan that has so often been advocated in our paper to prevent echo, which consists in fixing wires across the building. If the system cannot be regarded as original, the inventor deserves credit for being the first to apply wires for the distribution of sound in a building.

There are certain physical laws which Mr. Engert has taken into account in the improvements he has introduced, the most important of them being that law by which a string, when at rest, absorbs the particular undulation or musical note which it gives out when struck. It is well known that when a musical note is sounded in the presence of an instrument capable of sounding the same note, this instrument takes up the note and gives it out of its own accord. A piano or harp rings to the sound of another instrument which is touched, and in a like manner the strings or wires in Mr. Engert's apparatus absorb the vibrations of sound of the speaker or singer, and carry them off, preventing their return. The wires are tuned to the room, and their vibrations break the sound waves, and destroy the surplus ones w . . . so frequently create echo or confusion of sound. We may thus regard Mr. Engert's plan as the means of distributing the sound waves more evenly, and preventing the after sound, which is so destructive to voice and music in many of our public rooms. In air sound travels 1,100 ft. in a second, but in steel the speed is increased more than tenfold. One advantage of the system is its simplicity and readiness of application. It is not cumbersome or unsightly; it need not interfere with the architectural arrangements, no artificial ceiling or resonant walls are required. Buildings of semicircular shape and without the obstructions of columns and arches are rare; but the wires can be introduced in any room, indeed the value of the method is the readiness with which it can be applied to buildings of imperfect construction. We understand that the cost would be trifling. An ordinary church would probably require the expenditure of from £50 to £100, to fit it up with wires. Mr. Engert's experiments were necessarily rather incomplete, and we should like to see them tried in a church or lecture hall of confessedly bad character for sound. A committee of architects of the R. I. B. A. might well undertake the task of making a few experiments—there is no lack of suitable buildings to try them in. In the meantime the attention of architects individually may be directed to what seems a very useful remedy for imperfect acoustics in buildings.—*Building News.*

THE MANUFACTURE OF VINEGAR BY MEANS OF BACTERIA.*

By EMMANUEL WURM.

THE transformation of alcoholic liquids into vinegar has for a long time been a subject of scientific discussion. According to Pasteur the formation of vinegar is a physiological phenomenon, having for its cause the vegetation of a particular bacterium, the *Mycoderma aceti.* Liebig, on the contrary, saw in it only the chemical action of oxygen upon alcohol.

Pasteur has based his theory upon numerous experiments, and he has founded upon it a new process of manufacture which he made known in 1862, and described in detail in his work, "Etudes sur la Vinaigre," published in 1868. He proposed to produce vinegar by sowing the acetic mycoderm upon the surface of a mixture of wine and vinegar, or of water with which had been mixed besides 1 per cent. of acetic acid, 2 per cent. of alcohol and nutritive mineral salts. When about one-half of the alcohol had passed to the state of vinegar small quantities of alcohol were to be added daily until the liquid had received sufficient for the vinegar to have the strength required for commerce. In order to be able to add the alcohol without destroying the fungus by direct contact it was to be introduced by India-rubber tubes fixed at the bottom of the vat and pierced laterally with small orifices. The height of the liquid was not to exceed eight inches.

In 1869, Breton-Laugier, of Orleans, announced that he had organized a vinegar manufactory upon the principles of Pasteur, and that acetification was effected from seven to ten times more rapidly than by the process employed hitherto, consisting in acetifying wine in large vinegar vats. In 1870 the Société d'Encouragement de l'Industrie Nationale awarded to him a prize of one thousand francs for improvement in the manufacture of vinegar.

In Germany Pasteur's ideas did not find a favorable soil. Liebig, in his memoir on Fermentation and the Origin of Muscular Force, maintained his view, previously expressed, that the formation of vinegar by means of alcohol is not due to a physiological phenomenon; that acetic acid is not the product of *Mycoderma aceti*, but the result of a chemical oxidation. As a proof it was alleged that a shaving from the lowest layer in a vinegar generator which had been used during twenty-five years in the manufacture contained no vinegar fungus that could be detected by a microscopic examination.

In 1866 Professor Otto wrote, in his treatise on the manufacture of vinegar, that he had tried the process of Pasteur, and that he did not think it could be carried out practically. In the last edition of this work (revised by Professor Bronner in 1876) this statement still found place without a supplementary remark, and as other technological treatises are equally restrained in information on this subject, it may be concluded that up to the present time Pasteur's process has not been practiced in Germany. Mayer and De Knierym have, however, lent important support to the physiological theory by their work. They have proved, in fact, that even in the manufacture by generators the *Mycoderma aceti* exists in great numbers on the shavings.

Some observations that I had occasion to make in the Institute of Vegetable Physiology, Breslau, at the instigation of Professor Ferd. Cohn, placed it beyond doubt that an energetic production of vinegar is caused by the vegetation of *Mycoderma aceti (Bacterium mycoderma,* Cohn).

Encouraged by the favorable results obtained upon a small scale, and according to the instructions of Pasteur, I have attempted to carry on industrially the manufacture of vinegar from spirit of wine, and have succeeded in an extremely satisfactory manner.

In the manufacture in which I am engaged with this object, for a Breslau manufacturer, I use large wooden vats, into which are poured 200 liters of a mixture of vinegar, water, and alcohol, together with the mineral salts indicated by Pasteur (phosphate of potash, 0·1 per cent., phosphate of lime, 0·01 per cent., phosphate of magnesia, 0·01 per cent., and phosphate of ammonia, 0·02 per cent.) The vats are well closed with solid wooden covers, access of air taking place through small openings made in the side. The mycoderm is sown by means of a thin wooden spatula, in imitation of Breton-Laugier. The liquid in the vats is heated to 25° or 30° C., and the interior of the manufactory is maintained at a temperature of 30° C.

According to Pasteur the proportion of vinegar ought to be 1 per cent. But long continued observation has shown to me that a liquid so slightly acid is easily invaded by the mould fungus (*Saccharomyces mycoderma*), which hinders the extension of the acetic fungus, and, consequently, the formation of vinegar, by burning up the alcohol and changing it directly into carbonic acid.

Some experiments made specially with the object of studying the influence of the proportion of acid upon the development of the two fungi have proved that with 0·5, 1·0, and 1·2 per cent. of acetic acid the result is to multiply exclusively the pellicle of mould; with 1·6 per cent. there is a predominance of *Mycoderma aceti*; with 2 per cent. there is a pure cultivation of the latter. The mixture of 2 per cent. of alcohol, indicated by Pasteur, has been found advantageous. In these conditions the production was such that the fungus sown had at the end of twelve, twenty-four, or thirty-six hours, covered the entire surface of the vat.

I undertook the microscopic examination under the direction of Professor Cohn, to whom I would in this place express my profound gratitude for the active participation and support which he has accorded to me throughout my investigation. The result of this research has been as follows: The viscous pellicle of bacteria, sometimes thin, sometimes thicker, is not always identical. Three different forms can be distinctly observed, concerning which it cannot at present be said whether they proceed from one organism, constituting three different states of development, or whether, as Mayer presumed, there are three distinct organisms, capable of producing acetic acid.

With a proportion of 1 to 3 per cent. of acid there was observed specially the formation of a thick, viscous, and fatty skin, consisting of extremely small globules (micrococci), which while young occurred in contiguous rows, and which after a few days were changed into an animal glue through the formation of an intercellular substance. Upon augmenting the quantity of acid there were formed in this layer veins, rays, and spots of a less thickness, which extend more and more, while the original layer sinks to the bottom.

The new pellicle, more delicate and less viscous, was at first constituted of bacilli of variable length, disposed very closely by the side of one another. This layer also eventually became viscous, and was replaced by a more delicate pellicle of bacilli, especially when the addition of alcohol was not made with regularity. When the proportion of alcohol exceeded 3 to 4 per cent., irregularly curved and inflated filaments made their appearance.

Up to the present we have been unable to detect in these forms any difference whatever as to their power of acetification. It has only been established that the bacilli multiply also in a mixture containing 1 per cent. of acid, while the various micrococci do not form thick pellicles except when the proportion of acid is less. The observation of Mayer that the mycoderm of vinegar is very sensitive to changes in the proportion of acid is thus found to be limited to micrococci.

A much more important influence upon the different forms of vegetation ought to be attributed to the proportion of alcohol in the liquid in the vats. The viscous state is always occasioned principally by too small a quantity of alcohol. For the sowings only thin pellicles should be taken; the viscous pellicles of micrococci and bacilli germinate more slowly.

When the surface of the vat is entirely covered and the surrounding temperature is 30° C., the liquid becomes heated to 34° C., and at the same time a strong odor of acetic acid is given off.

The augmentation of acid, which is ascertained daily by titration, oscillates between 0·2 and 0·4 per cent. as the quantity of alcohol added is varied. Theoretically the 2 per cent. by volume of alcohol that is added ought to produce 2 per cent. of acetic acid, but practically the yield is less. According to the calculations of Bronner, in the generators with shavings the loss of alcohol rises in the preparation of "esprit de vinaigre" (ordinary crude vinegar) to 23 per cent., and in the case of the stronger vinegars to 12 or 15 per cent. In the process followed by us there was a loss by evaporation only at the commencement; afterwards it was prevented by the layer of vegetation. In all it amounted to from 10 to 15 per cent. One portion of this alcohol is used by the acetic bacteria in the construction of their constituent elements; another portion is changed into acetic ether by the action of acetic acid at the elevated temperature of the liquid.

Two per cent. of alcohol yielded 1·7 to 1·8 per cent. of acetic acid. In order, therefore, to obtain a stronger vinegar still more alcohol must be added to the liquor. Pasteur had already pointed out that the formation of vinegar may be stopped if the added liquor be too rich in alcohol. According to our experiments, the addition of alcohol ought not to be made when there is more than 0·5 per cent. in the liquid, and then it ought to be effected in such a way that the liquid which comes into contact with the fungus does not contain more than 0·5 per cent. of alcohol. In this manner we have succeeded in continuing the production until we have obtained liquids very rich in acid. The greater the proportion of acid becomes the more rigorously should the quantity of alcohol introduced equal the quantity used up.

When the vinegar has attained the desired strength it is drawn off into the clarifying vats, in order to free it from the turbidity produced by the particles of mycoderms. The vat is afterwards cleaned with brushes and filled anew.

The conditions for success in the manufacture are: A sowing of pure bacteria, a uniform temperature of 30° C., and a well regulated addition of alcohol. These conditions being exactly observed, the new process is easy of execution, and presents over those hitherto followed the following advantages:

(1) In taking for a term of comparison the yield in a given time, it will be found that the new process produces vinegar twice as rapidly as the old "quick" mode of manufacture. A comparison may also be made from the point of view of the capital required for plant. According to the data of Otto, three vinegar generators, having a height of 3 meters, working together and additions made every hour, yield daily about 120 liters of vinegar containing 4·5 to 5 per cent. of acetic acid. The same quantity is produced by ten vats, for each vat acetifies daily, on an average, 0·3 per cent., making for the 200 liters which each vat contains, 600 grammes of acetic acid daily, corresponding to 13 liters of 4·5 per cent. vinegar. Ten vats with accessories cost one-half less than three generators of the height mentioned above.

(2) The space required by the vats does not need, as in the case of the generators, to be of a particular height, seeing that the dimensions of the vats can be fixed at will. In any reasonable plant it would be less than that required for the generators.

One great inconvenience in the manufacture of vinegar in general is the appearance of vinegar eels, by which it may be completely arrested. The eels, as pointed out by Pasteur, because of their great need of oxygen, press towards the surface of the liquid, destroying by their swaying movements the pellicle of mycoderm and preventing it from reforming. In the generators they cover the shavings with their viscous mass and so render direct contact of the mycoderm with the liquid impossible. If they multiply much the temperature of the liquid is lowered. If the cooling be prevented the parts of the pellicle destroyed may be reproduced. In this case the eels take refuge in the upper part of the vessel and form a ring of viscosity above the layer of bacteria.

The same phenomenon is produced upon the shavings. Here also if the production of bacteria has taken place above the eels are deposited upon the sides of the vat. Sometimes, however, they multiply to such an extent that acetification is stopped. It is very difficult then to separate the eels. It becomes necessary to remove from the vat a portion of the shavings and treat them with boiling water. But in this way the mycoderm is destroyed at the same time, and it is only after from four to eight weeks that a new vegetation is formed and the work recommences.

It is obvious that in Pasteur's process the eels have not time to multiply so as to become injurious, since a vat is emptied and cleaned after from ten days to a fortnight.

It is necessary to take care that the sowings of mycoderm do not come from a liquid infected by the eels. These being

* From the *Moniteur Scientifique* for July.

visible to the naked eye such an accident is easily avoided. However, if a vat be invaded the liquid is drawn off and heated by means of boiling water or steam to 60° C. The vat is washed with boiling water and a little sulphuric acid, and then filled again with the liquid that has been heated and cooled. If the vat be kept clean and the vinegar used for the mixture be heated to 60° C. the eels cannot be produced.

To preserve from eels vinegar manufactured and in stock, an inconvenience frequently due to the unsuitability of the casks, recourse may be had to heating the vinegar to 60° in large casks with limited access of air. Pasteur, in his work before mentioned, describes a practical arrangement for this process of preservation.

Among the antiseptic agents there is one of which the preservative action is remarkable, *i. e.*, salicylic acid; 0·01 per cent., or 10 grammes per hectoliter, is sufficient to preserve vinegar from eels. Unfortunately, however, in presence of the least trace of iron it gives rise to an intense blue coloration. Now, in domestic use, vinegar is frequently brought into contact with iron, and the boiling vinegar would color blue black the green parts of vegetables, such for instance as cucumbers, because of the iron contained in their chlorophyl. For this reason it is necessary to give up the use of this excellent means of preservation in the case of vinegar.

Boracic acid also acts as an antiseptic, especially in the proportion of 0·04 per cent. or 40 grammes to the hectoliter. After three or four days the eels are killed in vinegar containing considerable numbers. Boracic acid not being injurious to the health, if it be used in very small quantity, there is nothing opposed to its employment. Formerly, manufacturers added to vinegar a small quantity of sulphuric acid, but the sanitary authorities in this country have forbidden the practice.

A vinegar preserved by chemical agents, however, can no longer be used in the further manufacture of vinegar, for the antiseptics destroy the acetic bacteria also. The most rational mode of preservation consists, therefore, in heating the vinegar to a temperature of 60° C., as recommended by Pasteur. In the manufacture in vats the production of eels is by this means rendered impossible.

The vinegar fly (*Musca cellaris* L.), which is found always where acid liquors are evaporating, may also cause the introduction of the vinegar eels. By walking upon the viscous disk it may get the eels attached to its feet and thus transport them to vats or sound generators. In the vats this may be avoided by making the covers fit well and covering the tubes and plugging the aeration orifices with cotton. With generators, in consequence of the continual affusions, the evaporation of the vinegar spreading over the soil renders the locality unfavorable; the vapor given off by the generators themselves also attracts the flies, the approach of which to them cannot be prevented, while the vats are completely protected.

The acetification of a new shavings generator requires six to eight weeks. According to the calculations of Paul Pfund, also, a generator absorbs 5 to 6 hectoliters of vinegar to acetify the shavings. Moreover, the vinegar produced has during the first four weeks a very distinct taste of the wood, communicated to it by the shavings. The generators ought, therefore, to be kept in action uninterruptedly.

The method of Pasteur, where the vinegar is formed by bacteria, gives, on the contrary, immediately and without loss of vinegar a salable article of good quality. Nevertheless, the vats in fermentation ought always to be under rigorous control. An insufficient addition of alcohol, or too great an excess of alcohol in the fermenting liquor, immediately slackens the fermentation or stops it entirely. But if the necessary proportions be exactly observed the practical execution presents no difficulty.

For the production of wine vinegar this method is the only rational one; for in this case it is not necessary to add alcohol, and the course of the manufacture becomes still more simple.

PROGRESS OF SUGAR ADULTERATION.

MR. GEO. T. ANGELL writes as follows to the Boston *Advertiser*:

Glucose is a cheap substitute for sugar. It is made in Germany from rags. It can be made from sawdust. It is generally made in this country by boiling corn starch in dilute sulphuric acid (oil of vitriol). It has grown in a few years from nothing to most colossal proportions. A single factory uses in making it over five million bushels of corn a year; another more than two millions I am told that it sometimes sells in large quantities as low as two cents a pound.

Dr. T. D. Williams, of Chicago, recently analyzed over a hundred samples of confectionery there, and found more than seventy per cent. were made wholly or in part of glucose. He also recently analyzed six samples of brown sugar procured from six different sources, and found they all contained glucose. Two of them, very light colored, dry, and apparently fine articles, containing 33½ and 41½ per cent. of glucose. A. Casamajor, chemist, in a paper read before the American Chemical Society, March 4, 1880, says he has found refined sugars largely adulterated with glucose.

Dr. O. W. Wight, Health Commissioner of Milwaukee, writes, November 8, 1879, that a chemist in charge of a glucose factory tells him that about twenty per cent. of glucose is put into granulated sugars; sixty to seventy per cent. into some brown sugars, and about forty per cent. into candies; that it is largely put into honeys, and constitutes the greater portion of many sirups.

Dr. Kedzie, President of the Michigan State Board of Health, some time since analyzed seventeen table sirups, and found fifteen of them made of glucose. In twenty samples of table sirups recently analyzed at Chicago only one was found unadulterated, and several of them were made almost entirely of glucose. In twenty-one samples recently analyzed by Dr. Kedzie, twenty were made wholly or very largely of glucose.

The editor of the Chicago *Grocer*, writes me that seven-eighths of all the sugars sold in Chicago are adulterated with glucose, and subsequently states in his paper that seven eighths of all the sirups sold in that market are of the same kind. I am told by a Chicago sugar dealer that ship-loads of it are sent to New Orleans to come back as New Orleans sugar and molasses. It is largely used not only by confectioners, but also by bakers, brewers, in jellies, jams, preserves, honey, maple sugar, beers, wines, liquors, and is constantly being put into new uses, and I am informed that it is sold in immense quantities to sugar refiners.

Recently a Glasgow, Scotland, grocer was fined for selling American honey which contained fifty-seven per cent. of glucose. What is the character of this article? Not as it may possibly be made in a chemist's laboratory at high cost, but as it is made and sold for two or three cents a pound in our markets. The Chicago *Grocer*, of September 25, 1879, says: "The manufacturers deny admittance to their factories." The Chicago *Tribune* says: "The manufacture is carried on with as much secrecy as the illicit distillation of spirits."

Professor Charles R. Fletcher, Chemical Lecturer to Boston University and State Assayer of Massachusetts, writes that he has recently analyzed three samples of best solid glucose and two samples of the sirup, grades A and B, and in every sample found free sulphuric acid (oil of vitriol). In one sample of best glucose he found thirty grains of oil of vitriol to the pound of glucose. In a sample of the best sirup he found nearly as much.

Dr. Kedzie (before quoted) found in one sample of glucose sirup 141 grains of oil of vitriol and 724 grains of lime to the gallon; and in another, which had caused serious sickness in a whole family, 72 grains of oil of vitriol, 28 grains of copperas, and 363 grains of lime to the gallon. Dr. T. D. Williams, of Chicago, states that in the various samples of glucose sugars and sirups he has found in every sample quantities of free sulphuric acid (oil of vitriol).

Dr. Williams also states, in a letter of April 9, 1880, that he has found glucose products almost invariably contaminated with lead, and that Professor Mariner, of Chicago, tells him that he has recently found lead in almost every sample he has analyzed. Professor Mariner testified last October that he had examined several glucose sirups, and found in them chlorides of tin, calcium, iron and magnesia, in quantities which made them very poisonous.

Dr. Wight, of Milwaukee, Commissioner of Public Health, writes, November 8, 1879, that an eminent chemist and college professor tells him that he has analyzed many specimens of sugar for muriate of tin, and has frequently found it in dangerous quantities. Professor Mariner, before quoted, testified last fall that out of fourteen samples of sugar analyzed by him, he had found in twelve of them tin in the form of a chloride, an active poison. The students in the School of Mines of Columbia College, New York city, extracted some time since quantities of tin from sugars, and hung the lumps to the necks of the bottles from which they were taken.

President Kedzie, at a meeting of the Michigan Board of Health, January 14, 1879, said that as a general thing cheap sugars in Michigan were adulterated, that poisonous materials were used to color sugars, and that A coffee sugars often and B and C coffee sugars almost always contained lead salts. The Journal of Materia Medica says "the use of tin in glucose sirups has been proved by numerous analyses."

In the valuable recently published book styled "Food Adulteration," I find a case in which the men employed in twelve different Michigan lumber camps were poisoned by eating glucose sirup. Mr. Stearns, the great manufacturing chemist of Detroit, told me last September that he could not buy a pound of sugar in Detroit which he could use to coat his pills. Dr. Kedzie says that hams cured with glucose have been found to mould, blacken by heat, and become bitter.

J. M. Chapman, a most respectable Chicago sugar dealer, testified in that city, last October, that, in his opinion, not more than one barrel of sugar in a hundred now sold in that city, is pure, the rest being what are called "doctored goods." Another large Chicago sugar dealer, J. H Dunham, at the same time gave evidence to confirm this statement. In the interests of Boston sugar merchants and grocers, and the far greater interests of public health throughout the great West, I think the contrast between Massachusetts sugars, as shown by Mrs. Richards, and Western sugars as shown by all these authorities, should be widely known; and I earnestly hope our State Board of "Health, Lunacy, and Charity" will push the investigation into all other articles of common household use.

The German Government caused 231,478 analyses of different articles to be made in the year 1878, and obtained 3,352 convictions in the courts. I know of no reason why similar precautions are not needed as much in this country as in Germany.

THE CHEMICAL REACTIONS OF MORPHINE.

DR. E. HOLDERMANN has published in the *Chemiker Zeitung* a short article on the chemical reaction of morphine, which reveals some new facts, and of which the following is a translation: By a well known reaction of morphine a yellow color is given to a solution of iodic acid in which morphine is present, and this yellow color is produced by the secretion of free iodine. When I first made a more exact investigation of this reaction, trying to find out if by means of the reduced iodine, the quantity of which was ascertained by iodometric analysis, a quantitative relation could be established between this iodine and the quantity of morphine by which it had been reduced, and when I further tried to discover what kind of a chemical compound the morphine had been reduced to during this reaction, I obtained some interesting results which I will describe in the following lines:

The chemical solutions used for my experiment were: 1. A solution of hydrochloride of morphine of known strength. 2. A solution of iodic acid, also of known strength. 3. Those solutions which are necessary for iodometric analysis, viz., sulphurous acid of 0·03 strength, and a solution of iodine of known quantity.

First, I tried to ascertain the real amount of iodic acid by adding an excess of SO_2, and by treating this liquid with a solution of iodine, believing that the following process would take place:

$$I_2O_5+5H_2SO_3=5H_2SO_4+I_2$$
$$I_2+H_2SO_3+H_2O=2HI+H_2SO_4$$

This process really takes place, but scarcely has one come to believe that a final result has been reached, when, after again adding an excess of SO_2, the blue color reappears (in presence of starch solution). This phenomenon is repeated after each adding of SO_2, be the quantity whatever, but the pauses after which the blue color (or if no starch is present the yellow color) reappears, increase. The reason of this play of reaction I attributed to the action of the light; and I found that I was right, for at an almost complete exclusion of daylight the pause before the reappearance of the color was nearly three times as long as when the experiment was made in the clear light of day. The increase in the pauses seemed to be dependent upon the increase of the dilution.

Making this assumption, I had, of course, no right to consider the reduction of iodic acid by means of morphine as the measure of the chemical process which takes place during this reduction, therefore I tried to discover if the reductive influence of the morphine could not be combined with another process of reduction, and I therefore chose the process which takes place during the distillation of bichromate of potassium with muriatic acid. It is well known that bichromate of potassium is reduced according to the following equation:

$$K_2Cr_2O_7+14HCl=2KCl+Cr_2Cl_6+7H_2O+6Cl$$

If this chlorine is led into a solution of iodide of potash an equivalent volume of iodine is set free. The quantity of iodine is determined by an addition of SO_2. If first a certain quantity of bichromate of potash has been examined as to its composition, and then a weighed quantity of it has been distilled together with a weighed quantity of hydrochloride of morphine after an addition of HCl, a certain relation between the quantities of chloride developed will be discovered. The quantity of chlorine will have been diminished in the same proportion in which the quantity of pure morphine contained in the hydro-chloride of morphine differs. In my future experiments I will try to ascertain whether this fact will be of any value for the quantitative determination of the morphine. The late experiments have been made principally to find out the reductive value of the morphine, and to draw from this value the conclusion, what chemical compound has been found by the oxidation of the morphine.

After having made a series of experiments, I have divided the quantity of iodine which disappeared by the atomic weight of the iodine, and the quantity of morphine contained in the used hydrochloride of morphine by the atomic weight of the morphine. In bringing the thus obtained quotients to their simplest relation by dividing both quotients by the smaller one, I have discovered that one equivalent of morphine nearly corresponds to nineteen equivalents of iodine, which seems to me very remarkable, for one molecule of morphine contains exactly nineteen atoms of hydrogen. The nineteen equivalents of iodine correspond to ^{19}O, which are used for the oxidation of the morphine molecules. It is possible that every two molecules of morphine unite with nineteen more atoms of oxygen, or that nineteen atoms O deprive two molecules of morphine of all their H while forming water.

PURIFICATION OF SEWAGE.

THE city of Paris, says the *British Medical Journal*, has practically tested various chemical and other means of dealing with its sewage, and is now irrigating about a thousand acres of land within five miles of the Tuileries. It is, therefore, interesting to find that on June 23d last the Municipal Council of Paris resolved, among other things, "To approve, first, the continuation of irrigation in the fields of Gennevilliers, and the carrying of the sewage to the lower northwestern part of the peninsula of St. Germain and adjoining farms, and the delivery of sewage from the conduits to persons on their routes who shall be willing, by agricultural, chemical, or other means, to cleanse it at their own expense and risk for the sake of what they may be able to get out of it, subject to rules to be prepared; secondly, to ask the Government, in case the 1,500 hectares (3,700 acres) should be insufficient for the purification of the sewage without annoyance to the neighborhood, to take into immediate consideration the extension of the present proposal and the irrigation of other districts in the valley of the Seine."

DONATO TOMMASI'S DEFINITION OF NASCENT HYDROGEN.

DR. DONATO TOMMASI, the renowned Florentine chemist, was a short time ago accused of plagiarism, and has, therefore, written a letter in which he shows the invalidity of this accusation. He writes as follows:

I have just received from the secretary of the Holland Society of Sciences in Harlem the original memoir of Dr. Phipson about catalytic force. In the first place, I have most sincerely to thank Mr. Von Baumhäuer for sending me, voluntarily, the work of Dr. Phipson. I have read this memoir with much interest; and though I do not share the ideas of my honorable adversary, I cannot help congratulating Dr. Phipson for the clear and learned manner in which he has treated so difficult a question as the catalytic force. Dr. Phipson, in his memoir, limits himself to the catalytic force, and to that alone; the question of the nascent state of bodies he scarcely touches. His pamphlet on the catalytic force consists of thirty-four pages, and Dr. Phipson dedicates not more than half a page to the nascent state of bodies. The following are the contents of this half page:

"It has been known, ever since chemistry existed as a science, how much the nascent state of a body influences the combinations which it is able to form; some combinations are only possible when one of the bodies is in a nascent state, while, for the formation of others, both bodies must be in this condition. That which is called the nascent state is, in my opinion, nothing else than the allotropic state of bodies that are about to form a compound. Some time ago I published this view of the case. Mr. Houzeau seems to be of the same opinion. It is almost unquestionable that whenever oxygen enters into combination, or when set free from a compound, it is in the state of ozone. Considering the results obtained with hydrogen, chlorine, bromine, sulphur, phosphorus, etc., we may well conclude that the same is true of all simple bodies, viz., that all those bodies can be in an allotropic state analogous to that of ozone; that they are in this condition at the instant when they enter into combinations—that is, they are then in a nascent state."

My own view about nascent hydrogen was expressed in the following manner:

"If hydrogen in a nascent state is endowed with a greater affinity than in an ordinary condition, this proves that, when set free from a combination, it contains the entire quantity of heat which was produced by its being set free. Consequently, nascent hydrogen is nothing else but ordinary hydrogen under different physical conditions. I regard nascent hydrogen as identical with hydrogen + calories. In fact, all the reductions produced with nascent hydrogen can be obtained with ordinary hydrogen at a very high temperature, and the differences observed between the hydrogen which is set free by chemical reactions show only that the quantity of heat which is set free by these reactions is not always equal."

Now I ask, What resemblance can be detected between the definition which Dr. Phipson has given and the one I have given?

How could Dr. Phipson say that my theory of the nascent state is the same as that advanced by him in 1858, with the only difference that I have put the word "caloric" in the place of "electricity," although Dr. Phipson, in his memoir, *does not once mention the word electricity?* What experiments has Dr. Phipson made to prove that nascent hydrogen consists only of hydrogen accompanied by

calorics or electricity, or of hydrogen in an allotropic state, similar to that of ozone, as he pretends?

None that I know of.

While I was the first to give a precise and scientific definition of what we call nascent hydrogen, and was also the first to gather a number of sufficient facts for the verification of this theory, I have devoted two years to the study of the nascent state of bodies, and have published ten memoirs on this subject, which are full of the records of numerous experiments. Of course I shall also have to make some remarks on the manner in which Dr. Phipson explains what he calls catalytic phenomena, but it does not belong to the subject matter of this note, and I will reserve it for another occasion. DONATO TOMMASI.

ELECTROLYTIC DETERMINATION OF SILVER.

By H. FRESENIUS and F. BERGMANN.

IT is generally known that silver can be precipitated in a compact metallic state from the solutions of silver cyanide or chloride in potassium cyanide by means of the electric current.

As far back as 1865 Luckow demonstrated that silver may be quantitatively determined in this manner. He pointed out at the same time that electrolysis may be made available in other manners for the quantitative determination of silver; either:

(1.) By the reduction of silver chloride at the negative pole, or—

(2.) By the separation of the silver from a neutral solution of silver nitrate.

Concerning the latter process Luckow states: "If the current from two Meidinger elements is conducted through a neutral dilute solution of silver nitrate, metallic silver in a spongy state is deposited on the platinum capsule which forms the negative pole, while at the same time the edge and the lower surface of the platinum disk forming the positive pole is covered with fine black needles of silver peroxide, which, however, disappear almost entirely on prolonged action of the current. If, when all the silver has been deposited, the supernatant liquid is decanted off, the separated metal is repeatedly washed with water, dried sharply, and the capsule weighed; the increase of weight gives the proportion of silver in the liquid a little lower than the reality. The loss is due to the fact that a small quantity of silver is deposited on the disk of the positive pole owing to the reduction of the peroxide."

In a more recent memoir on the application of the electric current in analytical chemistry (*Zeitschrift Anal. Chemie*, xix, p. 15), Luckow states:

"Silver is precipitated by the electric current from solutions containing not more than 8 to 10 per cent. of free nitric acid, in a very bulky metallic state; at the same time a little peroxide is deposited at the positive pole, the formation of which may be prevented by an addition of glycerine, milk, sugar, or tartaric acid." No further information has been published on the electrolytic separation of silver from nitric solutions.

In accordance with Luckow the authors observe that silver can be easily and completely precipitated from nitric solutions, whether neutral or containing free acid, but that it is disposed to take a spongy or flocculent form, so that it easily falls off from the electrode and cannot be readily weighed. The precipitate assumes this spongy state, especially when it has been deposited from a somewhat concentrated solution, by the action of a moderately strong current. By using dilute solutions and a weak current the authors have succeeded in throwing down the silver in a compact state, adhering firmly to the electrode and capable of being readily weighed. This result was only obtained in presence of free acid. From neutral solutions even a feeble current precipitated the silver in a flocculent state. The author's experiments were conducted with the same apparatus described in their memoir on the determination of nickel and cobalt.

The following proportions appear suitable for obtaining the deposit of metallic silver in a compact form: In 200 c.c. of liquid submitted to electrolysis there should be from 0·03 to 0·04 gramme metallic silver and 3 to 6 grammes free nitric acid, the electrodes being at a distance from each other of 1 cm., and the strength of the current such as to evolve 100 to 150 c.c. detonating gas per hour.—*Zeitschrift für Analytische Chemie.*

DETECTION OF SALICYLIC ACID IN WINE AND FRUIT JUICES.

By DR. L. WEIGERT.

THE well known reaction with ferric chloride is not available in deeply colored liquids, especially if the proportion of salicylic acid does not exceed two to three per cent. The author shakes up 50 c.c. of the wine for some minutes in a flask with 5 c.c. of amylic alcohol, pours off the supernatant liquid into a test glass, and mixes with it an equal volume of alcohol, in which the colorless amylic dissolves. To this mixture are added a few drops of the dilute solution of ferric chloride, which produces the usual well known deep violet color.

A PROFITABLE STRIKE.

WE have received a fine specimen of rice, says the New Orleans *Picayune*, grown by a thrifty old darky in one of our neighboring parishes—St. Charles. As the old man handed it to us his mouth widened into a broad grin, and for a moment or two he chuckled in that happy way peculiar to a thoroughly satisfied negro. Said he: "You see, boss, when dey was a strikin' up yonder last spring, dey comes to me to jine 'em; but I done tole 'em me an' my han's was striking' as hard as we kin. 'Why, how's dat?' dey said, 'we see 'em workin' in de field now.' Jes' so, I tole 'em, we's a strikin' right an' lef' for all we's wurf." And as the old fellow turned to go he added, "An's it's a payin' 'em now a dollar an' a half a day."

CUBIC CAPACITY OF THE SKULL.

IN taking account of the differences in the skulls of various nations, attention is at present directed to the cubic capacity of the great cavity of the skull, excluding the cerebellum. By means of this method some interesting facts have been revealed. On the west coast of Africa there exists a race with long, flat heads, whose skulls have the greatest capacity yet known. The Laplanders and Esquimaux have highly-developed skulls, their mean capacity being 1,546. The lowest stage of the English skull descends to 1,542. The inhabitants of the Canary Islands have 1,498, the Japanese 1,486, the Chinese 1,424, the Italians 1,475, the ancient Egyptians 1,464, the Polynesians 1,454, the negroes of different races 1,377, the Kaffers 1,438, the Hindoos 1,306, and the Andamanris, a dwarf people, only 1,220 cubic centimeters.

JOSEPH HENRY.*

By A. M. MAYER.

AT the meeting of the association in 1878, a committee, composed of Professors Baird, Newcomb, and myself, was appointed to prepare a eulogy on our revered and lamented colleague and former president, Joseph Henry. This—I will not say labor, but duty of affection—has devolved on me alone. I would that the other members of this committee had laid before you their tributes to his memory, because for years they had been closely associated with him in his social and professional life in Washington. Yet, while Professor Henry had been the friend of their manhood, he was the friend of my boyhood; and during twenty-five years he ever regarded me—as was his wont to say—with a "paternal interest." To his disinterested kindness and wise counsels is due much, very much, of whatever usefulness there is in me. Hence I have said that it is a duty of affection for me to speak to you about one who was my beloved friend. I shall not, however, attempt a biography of Joseph Henry, nor will I speak of his administrative life as director of the Smithsonian Institution, for this is known and valued by the whole world. His best eulogy is an account of his discoveries; for a man of science, *as such*, lives in what he has *done*, and not in what he has *said;* nor will he be remembered in what he proposed to do. I will, therefore, with your permission, confine myself chiefly to Henry *as the* discoverer; and I do this the more willingly because I am familiar with his researches, and also because Professor Henry, from time to time, took pleasure in giving me accounts of those mental conceptions which preceded his work, led him to it, and guided him in it. Rightly to appreciate a discoverer we should not look at his work from our time, but go back and regard it from his time; we should not judge his work in the fullness of the light of present knowledge, but in the dim twilight which alone illuminated him to then unknown—but now well-known—facts and laws. I will, therefore, endeavor first to present you with a clear, but necessarily very concise, view of the state of our knowledge of electricity when Henry began his original researches in that branch of science, and then point out the value of his discoveries by showing what they added to knowledge, and how they instigated and influenced the discoveries and inventions of other men. Henry began his electrical researches at the age of twenty-eight, in the year 1827, while he was professor of mathematics and natural philosophy in the Albany Academy. At these he continuously worked till 1832, when, at the age of thirty-three, he moved to Princeton College. After a year's break in his work, caused by the preparation of his course of lectures for the college, he is again at original research, and continues his contributions to electrical discoveries till 1842. Thus, during fourteen years, between the ages of twenty-eight and forty-three, he was a constant and fertile worker.

THE FIRST DISCOVERY.

As with many other men of originality, Henry's first essays were in the direction of improving the means of illustrating well-established scientific facts and principles. His first paper of October, 1827, is interesting because it was his first. In it he improves on the usual apparatus which had been used by Ampère and others to show electro-dynamic actions, by employing several turns of insulated wire instead of one, as had previously been the practice. Thus, for example, to show the directive action of the earth's magnetism on a freely-moving closed circuit, Henry covered copper wire with silk, and then made out of it a ring about twenty inches in diameter, formed of several turns of the wire. The extremities of this wire were soldered to zinc and copper plates. The coil was then suspended by silk filaments. On plunging the metal plates into a glass of dilute acid the ring rotated around its point of suspension till its plane took a permanent position at right angles to the magnetic meridian. By a similar arrangement of two concentric coils, one suspended within the other, he neatly showed the mutual actions of voltaic currents flowing in the same or opposite directions, which facts are the foundations of Ampère's celebrated law. We now reach a period when Henry appears as a discoverer, and truly one of no mean order. As I remember his narration to me in the year 1859, it was as follows: He said that one evening he was sitting in his study in Albany with a friend, when, after a few moments of reverie, he arose and exclaimed, "Tomorrow I shall make a capital experiment!" For several months he had been brooding over Ampère's electro-dynamic theory of magnetism, and he was then deeply interested in the phenomena of the development of magnetism in soft iron, as shown in the experiments of Arago and Sturgeon. At the moment he had arisen from his chair it had occurred to him that the requirements of the theory of Ampère were not fulfilled in the electro-magnets of Arago and of Sturgeon, but that he could get those conditions which the theory required by covering the enveloping wire with a non-conductor like silk, and then wrapping it closely around the soft iron bar in several layers; for the successive layers of wire, coiling first in one direction and then in the other, would tend to produce a resultant action of the current at right angles to the axis of the bar; and furthermore, the great number of convolutions thus obtained would act on a greater number of molecules of the bar, and therefore exalt its magnetism. "When this conception," said Henry, "came into my brain, I was so pleased with it that I could not help rising to my feet and giving it my hearty approbation." Henry did go to work the next day, and, to his great delight and encouragement, discoveries of the highest interest and importance revealed themselves to him week after week. When he had finished his newly-conceived magnet he found that it supported several times more weight than did Sturgeon's magnet of equal size and weight. This was his first original discovery.

I will now give, as far as possible, Henry's own words in narrating his subsequent investigations of these very interesting phenomena: "The maximum effect, however, with this arrangement and a single battery was not yet obtained. After a certain length of wire had been coiled upon the iron the power diminished with a further increase of the number of turns. This was due to the increased resistance which the larger wire offered to the conduction of electricity. Two methods of improvement, therefore, suggested themselves. The first consisted, not in increasing the length of coil, but in using a number of separate coils on the same piece of iron. By this arrangement the resistance to the conduction of the electricity was diminished and a greater quantity made to circulate around the iron from the same battery. The second method of producing a similar result consisted in increasing the number of elements of the battery, or, in other words, the projectile force of the electricity, which enabled it to pass through an increased number of turns of wire, and thus, by increasing the length of the wire, to develop the maximum power of the iron. To test these principles on a larger scale an experimental magnet was constructed. In this a number of compound helices were placed on the same bar, their ends left projecting, and so numbered that they could be all united into one long helix, or variously combined in sets of lesser length. From a series of experiments with this and other magnets it was proved that, in order to produce the greatest amount of magnetism from a battery of a single cup, a number of helices is required; but when a compound battery is used, then one long wire must be employed, making many turns around the iron, the length of wire and consequently the number of turns being commensurate with the projectile power of the battery. In describing the results of my experiments the terms *intensity* and *quantity* magnets were introduced to avoid circumlocution, and were intended to be used merely in a technical sense. By the intensity magnet I designated a piece of soft iron so surrounded with wire that its magnetic power could be called into operation by an intensity battery; and by a quantity magnet a piece of iron so surrounded by a number of separate coils that its magnetism could be fully developed by a quantity battery. "I was," said Henry, "the first to point out this connection of the two kinds of the battery with the two forms of the magnet, in my paper in *Silliman's Journal*, January, 1831, and clearly to state that, when magnetism was to be developed by means of a compound battery, one large coil was to be employed, and when the maximum effect was to be produced by a single battery a number of strands were to be used."

We will now return to Henry's study of the properties of his intensity magnet. This magnet was formed of a piece of iron one-fourth of an inch in diameter, bent in the U form and wound with eight feet of insulated wire. His batteries were two—one formed of a single element with a zinc plate four inches by seven, surrounded by copper and immersed in dilute acid; the other, a Cruikshank's battery, or trough, with twenty-five double plates. The plates of this battery were joined in series, and altogether had exactly the same surface of zinc as that in the single-cell battery. The magnet was now connected directly to the single cell. The magnet held up seventy-two ounces. Then five hundred and thirty feet of number 18 copper wire led the current from the cell to the magnet; it now supported only two ounces. Five hundred and thirty feet more of the wire were introduced into the circuit, and then the magnet held but one ounce. In these facts Henry faced the same results as confronted Barlow five years before, and caused Barlow then to say: "In a very early stage of electro-magnetic experiments it had been suggested [by Laplace, Ampère, and others] that an instantaneous telegraph might be established by means of conducting wires and compasses, but I found such a sensible diminution with only two hundred feet of wire, as at once to convince me of the impracticability of the scheme;" and such, at that day, seemed to be the common opinion of men of science. But this opinion is presently to be shown by Henry to be ill-founded, by reason of the ignorance of the relations which have of necessity to exist between the kind of battery and the kind of magnet in order to produce electro-magnetic action at a distance—relations which Henry was the first to discover. This accomplishment justly entitles him to be regarded as a man of genius and a discoverer of no mean order. This discovery will always remain the one important fact that was to be known, to be understood, and to be applied, before it was possible to have constructed any form of electro magnetic telegraph. Let us see how Henry made this discovery.

After ending the experiments with the one-cell battery and reaching results which seemed to confirm the opinion of Barlow as to the "impracticability of the scheme" of an electro-magnetic telegraph, Henry attached his magnet to the second battery, formed of twenty-five cells, arranged in series. The current from this battery was sent to the magnet through one thousand and sixty feet of the same wire as had been used in the experiments with the first battery of one cell. The magnet now lifted eight ounces. It had held up only one ounce, when with the same length of interposed wire the battery of one cell was used. He now attached his electro-magnet directly to the poles of the twenty-five cell battery, when, to his astonishment, it only held seven ounces. The same magnet, it will be remembered, when attached to the one-cell battery, supported seventy-two ounces. Here were facts of the highest significance, and Henry was not slow to seize them in all their bearings. Referring to these experiments, he said, in 1857: "These steps in the advance of electro-magnetism, though small, were such as to interest and astonish the scientific world. These developments were considered at the time of much importance in a scientific point of view, and they subsequently furnished the means by which magneto-electricity, the phenomena of diamagnetism, and the magnetic effects in polarized light were discovered. They gave rise to the various forms of electro-magnetic machines which have exercised the ingenuity of inventors in every part of the world, and were of immediate applicability in the introduction of the magnet to telegraphic purposes. Neither the electro-magnet of Sturgeon nor any electro-magnet ever made previous to my investigations was applicable to transmitting power to a distance."

Not satisfied with the mere statement that his discovery was "directly applicable to Mr. Barlow's project of forming an electro-magnetic telegraph," he actually constructed one, some time during the year 1831, around one of the upper rooms of the Albany Academy. It was more than a mile in length, and made signals by sounding a bell. This was the first electro-magnetic telegraph which had worked through so great a length of wire. It was the first "sounding" electro-magnetic telegraph. The relative parts played by Henry and Morse are described in Henry's "statement" published by the Smithsonian in 1857. "*The principles,*" says Henry, "*I had developed were applied by Dr. Gale to render Morse's machine effective at a distance.*" This statement seems to be as direct, as clear, as truthful, and as comprehensive as one can desire. I will take the liberty of remarking that had Henry taken out a patent in which he claimed as his invention an electro-magnet formed of two or more layers of insulated wire, Morse's patent would not have been so valuable. Remember, I speak not of the merit of the invention, but of the merit of the patent; for the invention, so far as Morse is concerned, would have remained the same, because one essential part of a Morse telegraph is Henry's intensity magnet, and certainly Morse never invented that.

* An address before the American Association, Boston, 1880. From the Boston *Daily Advertiser*.

If Ohm's law had been known to Henry, with all of its consequences, when applied to his discovery of the exaltation of the electro-magnetism of iron, in connection with his discovery of the proper relations necessary between batteries and magnet to get the greatest electro-magnetic effects, his discoveries would appear dwarfed, though yet of excellent workmanship. But did he at this time, 1827 to 1832, know of Ohm's law? I infer that Henry arrived at his discoveries independently of such knowledge, and for twofold reasons. First, Ohm's law was published as late as 1827, in Berlin, and was received almost contemptuously. Henry was unable to read German, and Ohm's papers were first published in English in 1841. Secondly, from the manner in which Henry worked at his problems and viewed his results, I conclude that he had no knowledge of Ohm's laws; else why should he have been astonished at the effects when his intensity magnet was connected with his intensity battery? Henry, now in possession of powerful magnets, began to work on another problem. He tried to do the reverse of what he had already done. His magnet was made by the action of the electric current, and he now tried to obtain an electric current from the magnet, and he succeeded. Henry and Faraday independently discovered the means of producing an electric current and spark from a magnet. Tyndall speaks of this experimental result as "the Mont Blanc of Faraday's own achievements." A few words now will place Henry in his proper and just relations to these important discoveries. All the information he had received from Faraday's discovery was the account of Faraday's production of magneto-electricity by the sudden insertion of a magnet into a helix and its sudden withdrawal therefrom. Henry's experiment is entirely different, and certainly was entirely original with him; but it is essentially identical with another of Faraday's of which Henry had no knowledge. Thus it appears that, although Henry cannot be placed on record as the *first* discoverer of the magneto-electric current, he stands alone as its *second* independent discoverer.

THE SECOND DISCOVERY.

Henry's next discovery was that of the induction of a current upon itself, or of the extra current, as it is sometimes called. Here he anticipated Faraday by nearly two years and a half in the observation of the fundamental facts. Notwithstanding an explicit disclaimer of Faraday, the credit of this discovery has been generally given to the latter. This is accounted for by the fact that, although Henry anticipated others in his observations, he had not leisure to follow them up to their full explanation until after Faraday had completely unraveled their nature. In 1838, after his return from a first visit to Europe, Henry discovered an entirely new class of phenomena in electrical induction. He first showed that an induced current may excite a second induced current in a neighboring closed conductor, that this last may induce a third current, and so on. These currents Henry styled currents of the first, second, third, etc., orders, and he showed that they alternate in their direction successively. He investigates the differences in these currents as they flow through different resistances. The same phenomena he tracks through the inductive sections of the discharge of the Leyden jar and of the frictional electrical machine, and shows how they differ from those produced by the voltaic battery. These researches are the most finished of Henry's investigations, and will ever be regarded as models of careful and thorough scientific work.

Henry had a versatile mind, and did not confine his attention to the study of electricity. His researches in molecular physics, though not extensive, are remarkable. Here his suggestions and methods have stimulated others to follow in the paths which he has pointed out. In 1839 Henry made a curious discovery as to the permeability of lead to mercury. He found mercury would even ascend a lead wire to the height of a yard in a few days. He even made what might be called siphons of lead, which would nearly empty a vessel of mercury by drawing the fluid over its sides. Subsequently, in 1845, with Mr. Cornelius, he proved that copper, when heated to the melting point of silver, would absorb the latter metal. In 1844 Henry was investigating the nature of the forces acting in liquid films. Studying the tenacity of the soap bubble film, although his experiments could only furnish approximate results, they showed that the molecular attraction of water for water is really several hundred pounds to the square inch, and probably equal to the attraction of ice for ice. Another of Henry's investigations, having a practical bearing, should be more widely known than it is. Among his duties as chairman of the United States Lighthouse Board was the testing of the various physical properties of the oils submitted to the government for purchase. Fluidity was one of these properties for which it seemed most difficult to get reliable tests. Here he very ingeniously applied the theorem of Torricelli, which shows that equal quantities of all liquids of equal fluidity will flow out of an orifice in equal times. Henry found that with different oils the flow of equal quantities differed, the rapidity of flow of sperm oil exceeding that of lard oil in the ratio of 100 to 167. Alcohol proved to be less fluid than water. Henry took a deep interest in acoustics. His additions to this science were chiefly the results of experiments upon fog signals. He made extensive experiments with various sound producing instruments, and eventually decided in favor of the steam siren fog horn. He determined that these instruments send their sound farthest when tuned very near to the treble C, and he also showed the uselessness of applying reflectors to them. During eleven years Henry sought to advance the efficiency of our fog signals by experiments in all weathers. Many very puzzling facts were collected. Thus it was observed that a sound coming to a mariner against the wind would cease to be audible on the deck of his vessel while it continued to be heard at the masthead. It was also observed that upon approaching a fog horn from a distance the intensity of sound would gradually increase, then die down rapidly, become inaudible through a space of three or four miles, and perhaps not reappear until the vessel was within a mile of the instrument. These facts demanded explanations, and for a long time remained enigmas to Henry; till one day he met with a paper by Professor Stokes, in which the effect of an upper current in deflecting a wave of sound is fully explained. This hypothesis of Stokes Henry was able to apply to the solution of the problems in question.

Henry's services to the Lighthouse Board were of great value to the country. The fact that his investigations showed that lard oil heated to about 250° Fahr. is superior in fluidity and illuminating power to sperm oil caused the substitution of the former for the latter. A dollar a gallon was saved, which amounts to about one hundred thousand dollars a year in favor of the government. In light and heat Henry made several investigations which we must pass over. One, however, is so important that it cannot be omitted. I refer to his application of the thermopile to determining the distribution of heat on the optical images of distant objects. In a bold and wonderful experiment he sought to study the distribution of heat on the surface of the sun. In 1845, with Stephen Alexander, he formed an image of the sun, by means of a telescope, upon a screen. In this screen was cut an aperture, closed by the surface of a thermopile. By a motion of the telescope any part of the image could be brought upon the pile. A solar spot being present, he clearly proved that it emitted less heat than the surrounding parts of the luminous disk. This method of research was shown to Secchi. On his return to Europe the latter made no small repute by extending these observations, using Henry's methods, but often, I fear, not giving full credit to the originator. But let that pass, for the bread which Henry cast upon the waters has returned to our own shores, thanks to the genius of our colleague Langley.

THE MAN OF GENIUS.

It is impossible to crowd into one brief hour the thoughts which were his occupation during more than half a century. I have at least endeavored to exhibit the more important of the labors of his life. What shall we think of them? Surely they are on as high a plane as those of any of his contemporaries, and show as much originality as theirs in their conception—as much skill in their execution. Yet it has been said that Henry was not a man of genius. As I have not been able to find that the philosophers, who have the special charge of giving from time to time definitions of genius, have been able to come to any satisfactory conclusion among themselves, I will leave their company, and, with your liberty, take my definition from a book which, if we accredit Thackeray, is one of the very best, if not the best, novel ever writ in English. After listening to this I will allow you to form your own opinions as to whether Henry did or did not possess genius. "By genius I would understand that power, or rather those powers of the mind which are capable of penetrating into all things within our reach and knowledge, and of distinguishing their essential differences. These are no other than invention and judgment, and they are both called by the collective name of genius, as they are of those gifts of nature which we bring with us into the world. Concerning each of which, many seem to have fallen into very great errors; for by invention, I believe, is generally understood a creative faculty, which would indeed prove most romance writers to have the highest pretensions to it; whereas by invention is meant no more, and the word so signifies, than discovery in finding out; or, to explain it at large, a quick and sagacious penetration into the true essence of all the objects of our contemplation. This, I think, can rarely exist without the concomitancy of judgment, for how we can be said to have discovered the true essence of two things, without discovering their difference, seems to me hard to conceive. Now this last is the undisputed province of judgment; and yet some few men of wit have agreed with all the dull fellows in the world in representing these two to have been seldom or never the property of one and the same person." My own judgment, if of any value, would rank the ability of Henry—I do not say his achievements—a little below that of Faraday. Indeed, their lives and their manners of working were strangely alike. Faraday was the son of a blacksmith. He once wrote: "I love a smith's shop and anything relating to smithery. My father was a smith." Henry's father plied a schooner on the Hudson. Each started in life with moral and benevolent habits, well developed and healthy bodies, quick and accurate perceptions, calm judgment and self reliance, tempered with morality and good manners—a good ground, surely, in which to plant the germs of the scientific life. Faraday was an apprentice to a bookbinder. Henry served in the same capacity under a silversmith. Each, endowed with a lively imagination, was in his younger days fond of romance and the drama; and, by a singular similarity of accidents, each had his attention turned to science by a book which chance threw in his way. This work in the case of Faraday was "Mrs. Marcet's Conversations on Chemistry," and the book which influenced Henry's career was "Gregory's Lectures on Experimental Philosophy, Astronomy, and Chemistry." Of Mrs. Marcet's book Faraday thus writes: "My dear Friend—Your subject interested me deeply every way; for Mrs. Marcet was a good friend to me, as she must have been to many of the human race. I entered the shop of a bookseller and bookbinder at the age of thirteen, in the year 1804, remaining there eight years, and during the chief part of the time bound books. Now it was in those books, in the hours of the week, that I found the beginning of my philosophy. There were two that especially helped me—the Encyclopædia Britannica, from which I gained my first notions of electricity, and Mrs. Marcet's "Conversations on Chemistry," which gave me my foundation in that science. Do not suppose that I was a very deep thinker, or was marked a precocious person. I was a burly, imaginative person, and could believe in the Arabian Nights as easily as in the Encyclopædia. But facts were important to me and saved me. I could trust a fact, and always cross-examined an assertion. So when I questioned Mrs. Marcet's book by such little experiments as I could find means to perform, and found it true to the facts as I could understand them, I felt that I had got hold of an anchor in chemical knowledge, and clung fast to it. Thence my deep veneration for Mrs. Marcet—first, as one who had conferred great personal good pleasure on me; and then as one able to convey the truth and principle of those boundless fields of knowledge which concern natural things to the young, untaught and inquiring mind. You may imagine my delight when I came to know Mrs. Marcet personally; now often I cast my thoughts backward, delighting to connect the past and the present; how often, when sending a paper to her as a thank offering, I thought of my first instructress, and such thoughts will remain with me."

Henry wrote on the inside of the cover of Gregory's work the following words: "This book, although by no means a profound work, has, under Providence, exerted a remarkable influence on my life. It accidentally fell into my hands when I was about sixteen years old, and was the first book I ever read with attention. It opened to me a new world of thought and enjoyment; invested things before almost unnoticed with the highest interest, fixed my mind on the study of nature, and caused me to resolve at the time of reading it that I would immediately begin to devote my life to the acquisition of knowledge—J. H." Each of these philosophers worked with simple instruments, mostly constructed by his own hands, and by methods so direct that he appeared to have an almost intuitive perception into the workings of nature; and each gave great care to the composition of his writings, sending his discoveries into the world clothed in simple and elegant English. Finally each loved science more than money, and his Creator more than either. There was sympathy between these men, and Henry loved to dwell on the hours that he and Bache spent in Faraday's society. I shall never forget Henry's account of his visit to King's College, London, where Faraday, Wheatstone, Daniell, and he had met to try and evolve the electric spark from the thermopile. Each in turn attempted and failed. Then came Henry's turn. He succeeded, calling in the aid of his discovery of the effect of a long interpolar wire wrapped around a piece of soft iron. Faraday became as wild as a boy, and, jumping up, shouted, "Hurrah for the Yankee experiment." And Faraday and Wheatstone reciprocated the high estimation in which Henry held them. During a visit to England, not long before Wheatstone's death, he told me that Faraday and he had, after Henry's classical investigation of the induced currents of different orders, written a joint letter to the council of the Royal Society, urging that the Copley medal, "that laurel wreath of science," should be bestowed on Henry. On further consultation with members of the council it was decided to defer the honor till it would come with greater *éclat*, when Henry had continued farther his researches in electricity. Henry's removal to Washington interrupted these investigations. Wheatstone promised to give me this letter to convey to Henry as an evidence of the high appreciation which Faraday and he had for Henry's genius, but Wheatstone's untimely death prevented this. Both Faraday and he gave much thought to the philosophy of education, and in the main their ideas agreed. I may in this connection be excused from reading abstracts from a letter from Henry soon after he had received the news that I had given my son his name. After a playful discussion of the name Joseph, Jo, and Josey, he says—what may be news to most of you: "I did not object to Henry as a first name; although I have been sorry that my grandfather, in coming from Scotland to this country, substituted it for Hendrie, a much less common, and therefore, distinctive name." He then proceeds: "I hope that both his body and mind will be developed by proper training and instruction, that he may become an efficient, wise, and good man. I say efficient and wise, because these two characteristics are not always united in the same person. Indeed, most of the inefficiency of the world is due to their separation. Wisdom may know what ought to be done, but it requires the aid of efficiency to accomplish the desired object. I hope that in the education of your son due attention may not only be given to the proper development of both these faculties, but also they will be cultivated in the order of nature; that is, doing before thinking, art before science. By inverting this order much injury is frequently done to a child, especially in the case of the only son of a widowed mother, in which a precocious boy becomes an insignificant man. On examination in such a case it will generally be found that the boy has never been drilled into expertness in the art of language, of arithmetic, or of spelling, of attention, perseverance, and order, or, in other words, of the habits of an active and efficient life."

Henry was a man of extensive reading, and often surprised his friends by the extent and accuracy of his information, and by the original manner in which he brought his knowledge before them. Not only was he well versed in those subjects in which one might naturally suppose him proficient, but in departments of knowledge entirely distinct from that in which he gained his reputation as an original thinker. Although without a musical ear he had a nice feeling for the movement of a poem, and was fond of drawing from his retentive memory poetic quotations apt to the occasion. He was a diligent student of mental philosophy, and also took a lively interest in the progress of biographical science, especially in following the recent generalization of Darwin; while the astonishing development of modern research in tracking the history of prehistoric man had for him a peculiar fascination. Yet with all his learning, reputation, and influence, Henry was as modest as he was pure. One day, on opening Henry's copy of Young's Lectures on Natural Philosophy, a book which he has studied more than any other work of science, I read on the fly leaf, written in his own hand, these words:

> "In Nature's infinite book of secrecy
> A little I can read."—*Shakespeare.*

And did he not read a little "in Nature's infinite book of secrecy?" And did he not read that little well? May we all read our little in that book as modestly and as reverently as did Joseph Henry.

CHEMISTRY AS AN ART AND AS A SCIENCE.*

By PROF. J. M. ORDWAY.

THE past year has been one of laborious activity in chemistry, but it has not been marked by any epoch-making discoveries. Meyer's recent apparent resolution of the chlorine molecule has not, indeed, been verified by the carefully-devised experiments of Crafts, but the latter does seemingly confirm the change of iodine by intense heat. The years 1879 and 1880 will rank hereafter as years in which Meyer found means to throw new light on the nature of the haloids. Twenty-four years ago Perkin sought for artificial quinine, and found instead a better than royal purple. Then, by various hands and in rapid succession, red and yellow and black and brown and blue dyes were brought out from what proved to be something more than aniline. Now the novelty is past, and the announcement of a new dye hardly creates a ripple of excitement. The twelve-year-old synthesis of alizarine has given us colors purer, brighter, faster, and cheaper than those of the obsolescent madder.

Of late, wool has been provided for, and the extinction of cochineal plantations is threatened by reds of surpassing brilliancy, durability, and ease of application. Baeyer has recently effected the synthesis of indigo, and tropical indigo fields may in time share the fate of the madder farms of France and Turkey. But indigo itself will not continue to satisfy our demand. We have become accustomed to hues of a delicacy and richness that no one dared to dream of twenty-five years ago. The æsthetic taste of this generation has been too much pampered; and dyers will soon call for something uniting the brilliancy of the aniline blues with the fixedness of indigo, and its adaptedness to wool and cotton. And Germany, which has done the most in studying out these extraordinary colored compounds, now furnishes the most of the industrial fruits of seemingly unpractical reseaches. Investigation costs, investigation pays; in more senses than one our science "opens wide her everduring gates on golden hinges turning."

The passing years are bringing to light new elementary bodies, and new metals are becoming like new asteroids, of too little mass to influence the orbits of other planets, and too much out of sight to interest many. Within five years fourteen new metals have called for recognition; and in

* From an address before the American Association, Boston, 1880.

1879 alone chemists have claimed the discovery of six. Of new alloys, manganesian copper is worthy of regard, since it may in a measure play the part for copper that *spiegeleisen* does for steel.

In 1620 Bacon published the second part of his "Novum Organum," wherein he pointed out the way to appeal to nature by experiment, instead of deriving all science from the teaching of the ancients. But his methods had little immediate influence on the science of the time. He relied on induction; and induction alone simply strings together dry bones. That perception of general principles which makes science comes not altogether from the mere collation of facts. We need something more than eyes to see.

The great chemist of two hundred and fifty years ago was Van Helmont. To him we owe the word gas, which he derived not from geist, but from chaos, as representing the original form of matter. When our forefathers were laying the foundations of this nation alchemy was in its dotage, and chemistry took its rise in a dim knowledge of the gases. The evolution of chemistry as a science was threefold. First, the study of the gases, then the study of combining weights. Consider how much of what we know depends on the gases that Cavendish, Black, Scheele, and Priestley revealed. The study of combustion, respiration, vegetable growth, organic decay, geological transformation, and hygiene involves the study of carbon dioxide. Carbon monoxide reduces the metals and plays a part in the Bessemer process for making steel. The fuel of the future is to be coal resolved into a chaos of carbonic oxide and hydrogen.

At the end of the last century Murdoch found a use for coal gas, and in its train came a host of secondary products having a marvelous effect on science and industry. A test came into chemistry when Beecher attempted to explain combustion. Vulcan of old made as good iron as the blacksmith requires to-day. As for quantity, Vulcan, with all his Cyclops and the fires of Ætna, could not produce as much in six days as the Cambria iron works turn out in six minutes.

Glauber, with all his good sense, taught that the rays of the sun and stars shoot themselves into the earth, and finally became silver and gold. Perhaps he was a prophet, speaking in symbols which he understood not. Now we know that metallurgy does depend on the sun's rays. The sunshine of the carboniferous period has been materialized into coal beds, and now attains perfection in a metal of more real value than gold. In the chemical study of heat, Berthelot's recent work shows culminating progress, and is worthy of him who years ago almost created organic synthesis.

After a review of some of the most abstruse speculations in theoretical and physical chemistry, Professor Ordway went on to discuss the importance of biological chemistry. This branch is yet in its infancy, and has few to tenderly care for it. Most chemists prefer to take easier subjects, but the interest in it is increasing. The field is large and there is room for many laborers. Proximate organic analysis still remains undeveloped, and the world does not comprehend the light that we already have.

In fermentation, putrefaction, vitrification, and zymotic diseases, life may intervene; but how much do we yet know as to what is cause and what is merely concomitant? It is pertinent to ask whether chemistry tends, as many think all physical science tends, to materialism. I believe no true science tends that way; it is the lack of liberal cultivation that leads to such dimness of vision. Materialism is no more prevalent now than among the Athenians, who had no physical science. We hear much of the culture of that people, as if æsthetics were the only science and floriculture the only culture.

There is much in the training of the chemist to foster a wholesome skepticism and just intolerance; intolerance of human pride and skepticism of airy theories. In chemical practice the constant appeal to sensible tests and the precision of the balance checks reliance on hasty assumptions. The chemist soon learns that exact truthfulness in others and rigid honesty in himself lie at the very foundation of science and real knowledge; and he looks on laxity in experiment or statement as the unpardonable sin. No other subject is so well calculated to impress one with the idea that theories are but the changeable dress of science. We all wonder what will become of the atomic theory itself when its centennial comes round twenty-seven years hence.

THE PRESENT CONDITION OF ASTRONOMICAL SCIENCE.*

By ASAPH HALL.

THE present condition of astronomy is the result of the continued labors of our predecessors for many generations, and to this result the lapse of time itself has largely contributed. For the full development of the secular changes of our solar system, for an accurate knowledge of the proper motions of the stars of our sidereal universe, and of the great changes of light and heat that are going on among them, the astronomer must wait until future ages. It is his present duty to prepare for that future by making the observations and investigations of his own day in the best manner possible; and to do this needs a careful consideration of the present condition of the science. Although the objects for observation have become so numerous, and the range of investigation so wide, that there is room for the most varied talent and skill, yet there is danger that there may be a waste of labor either in duplicating work or in doing it in an improper manner. Especially may this happen in observations of the principal planets of our system and of the fixed stars. In the case of the planets the observations are abundant, and the orbits are already well determined, except that of Neptune, for which, on account of its slow motion, we must of necessity wait for time to develop its small peculiarities, if such there be. For all these planets the observations at one or two observatories are amply sufficient, and even then the observations ought to be confined to a short time near the opposition, or at quadrature, and so made that they may be easily combined into a single normal position, which will suffice for the theoretical astronomer. To scatter such observations over a period of several months is to throw away one's labor, and to leave to the computer the disagreeable duty of rejecting a part of the observations as useless. It seems to me, therefore, unwise for several observatories to continue keeping up observations of the four outer planets of our system, when ten observations a year of each planet will give all the data that are needed. Again, for all the principal planets, observation is now in advance of theory, except, perhaps, in the case of one or two of them.

The first step toward a rational and trustworthy knowledge of our sidereal universe must come from a determination of the distances of the stars. The solution of this problem was attempted soon after the Copernican theory of our solar system was established, when it was seen that we have a long base line for our measures, or the diameter of the earth's orbit, and it was supposed that the solution would be easy. These early trials were all failures, but they led to some very interesting and important discoveries, such as Bradley's discovery of the aberration of light; to the knowledge of the fact that the determination of the parallaxes, or the distance of the stars, although simple in theory, is practically a difficult question, and then to an improvement in the instrumental means of observation, to a careful study of the methods of observation and the instruments, and to a recognition of the necessity of a complete and rigorous reduction of the observations. An examination of these early attempts is an instructive study. It is only about forty years ago that the solution of this problem was at last attained, and then only by the application of the most powerful instruments and the best observing skill. An interesting result of the determinations of stellar parallax is obtained at once in the check it puts on speculations concerning the structure of the sidereal universe. The first astronomers who considered the parallaxes of the stars very naturally assumed that the bright stars are nearer to us than the faint ones, and, therefore, they observed the bright stars for parallax. Now, while this assumption may be true as a general statement, the actual determinations of parallax show that some of the faint stars which are not visible to the naked eye are much nearer to us than the brightest stars of our northern sky. Again, it was assumed that a large proper motion is a certain index of a star's nearness to us; but observation shows that this also may be an erroneous assumption. This is a problem whose solution is only just begun, but already we know enough of its difficulties to see that we need the most powerful micrometrical apparatus that can be brought into use. The invention of some micrometer that, while as accurate as the present filar micrometer, would give the observer a much greater range of observation, and enable him to select suitable stars of comparison, is something much to be desired. At present the heliometer seems to be the best instrument for observations of this kind. Formerly it was thought that photography would furnish a good method for such delicate determinations; but so far the photographic methods have not given the necessary degree of accuracy in the measurements, and the astronomical use of photography is confined mostly to descriptive astronomy, where, especially in solar eclipses, it has rendered excellent service. Closely connected with the parallaxes of the stars and their proper motions is the interesting question of determining their motions to or from our sun according to the theory of Doppler. Here likewise the numerical determinations are so discordant that we cannot have much confidence in the results. In both these cases we need more powerful apparatus, and a complete and thorough investigation of the methods of observation. Perhaps some of the large instruments now constructing may be employed in these methods, and we may soon have better results.

There are many subjects in astronomy that need investigation, but in most cases the labor required is very great, and the completion of the work would occupy a long time. This follows, of course, from the fact that, with the refinement of observations and their exact reduction, many small terms must be considered which formerly could be neglected. The lunar theory has been a vexed question for the last two centuries, and may remain so for a long time to come. This will no doubt be the case until some able astronomer, with the will and perseverance of Delaunay, shall undertake its complete revision. This question should now be looked on as a purely scientific one, and its definite solution should be undertaken. The theory should not be patched up by guess-work to fit the observations, but should be carried out with the utmost rigor. This is a problem to which a young and able mathematician may well devote his life, and we must expect its solution from some such clear-headed devotee of science. Several of the planetary theories need a new investigation, and some of them are already in the hands of able astronomers. That of Mercury is especially interesting in connection with the intra-Mercurial planets, and it is to be hoped that Leverrier's theory of this planet may soon have a careful revision.

There is one point to which astronomers should give more attention, and from which we may reasonably hope that great advantages to astronomy may come: and that is to the selection of sites for new observatories. It is possible, perhaps probable, that our instruments may be greatly enlarged and improved, and that important discoveries and improvements in the manufacture of optical glass may be made; but it seems certain that we have within easy reach very decided advantages for astronomical work by the choice of better positions for our instruments. Very few American observatories have been established for the purpose of doing scientific work, or with much thought or care for their future condition; but generally they are built in connection with some college or academy, and are the product of local and temporary enthusiasm, which builds an observatory, equips it with instruments, and then leaves it helpless. The atmosphere that surrounds us, and its sudden changes of temperature, are the great obstacles to the good performance of a telescope; and the larger the instrument, and the higher the magnifying power, the more serious are these hinderances. Now, with our present means of travel, we can easily place our instruments at an altitude of eight or ten thousand feet, and above a large part of the atmosphere. In this way we may be able to do with small instruments what at common altitudes can be done only with large ones; and, when possible, it is always better to use small instruments, since they are more easily handled, and are relatively stronger and better than large ones. Uniformity of temperature may be secured by seeking locations in the tropical islands, or on coasts like that of California, where the ocean winds keep the temperature nearly uniform throughout the year. At great altitudes we may secure a clearness of vision that would be of the greatest value in the examination of faint objects, and by this means, and by persevering and continuous observation, interesting discoveries may be made. It is a matter of course that, except in the case of comets, the future discoveries in astronomy will belong to faint and delicate objects; but these are interesting, and should not be neglected. A uniform temperature, which secures good definition, and steady images of the stars, is necessary for accurate determinations of positions, and for all measurements of precision. This condition is especially important in such work as that of stellar parallax, the determination of the constant of aberration, and wherever the yearly change of temperature may act injuriously. In the selection of better sites for observatories, I think we have an easy means of advancing astronomy.

In presenting his exposition of the nebular hypothesis, which has since become so celebrated, Laplace says: "I present this hypothesis with the distrust which everything ought to inspire that is not a result of observation or of calculation." It is a singular fact that, among all the writings on the nebular hypothesis, I have never seen a reference to this presentation of it by its most distinguished advocate; and yet this is the true spirit of scientific astronomy. Laplace did not wish to exempt his own theories from criticism, and neither should any one. In astronomy there is no final human authority, no synod or council, but simply an appeal to reason and observation. If a theory or a discovery be true, it will stand the test of observation and of calculation; if false, it must pass away to that Miltonian limbo where so many things have gone and are going. The question is sometimes asked, Of what use is astronomy? and the reply generally made is that it has conferred great benefits on navigation and on commerce, since it is by means of his astronomical knowledge that the sailor determines the position of his ship on the ocean. There is a truth in this reply, but it is only partial. The great value of astronomy is that it is really a science, and that it has broken the path and led the way through which all branches of science must pass, if they ever become scientific. It is the spirit of honest, unrelenting criticism, and of impartial examination, that finally eliminates error and awards to every one his just due, that makes astronomy honorable and attractive; and it is by cultivating this spirit that astronomy confers its chief benefit, for it is this that shall break in pieces and destroy all false assumptions in science and in philosophy.

* Address before the American Association, Boston, 1880.

PYRETHRUM THE BEST INSECT KILLER.

SINCE we found, in 1878, that pyrethrum powder was so thorough and effective in killing the cotton worm, and particularly since the favorable results obtained by its use in the open cotton field a year ago, as shown in our February number (p. 43), we have had a firm belief that it is to be the insecticide of the future, and that instead of the thousands of tons of Paris green, and other poisonous and dangerous arsenical compounds that have been sold all over the country, for use against the Colorado potato beetle, the cotton worm and other great insect pests, we shall soon have this pyrethrum extensively cultivated and used. The sole objection to it now is the cost; and while those who manufacture it and put it on the market in small powder packages would like to monopolize its growth and production, they cannot long do so. It grows almost as easily as mayweed or oxeye daisy, and we have taken steps to have it tested and introduced in several different sections.

Having, a year ago, commenced a series of experiments which are being continued, we shall report the results from time to time, and commence with the following notes of a series made in July, 1879, under our direction, by Mr. W. A. Henry, of Ithaca, N. Y.

DIRECTIONS FOR RAISING PYRETHRUM.

We have lately been obtaining and distributing on behalf of the U. S. Entomological Commission, the seed of this valuable plant for trial in the Southern States. The following directions for sowing and cultivating have been furnished us by the California growers. That quite so much care is necessary, or that any more is required than for the cultivation of other compositæ, is doubtful, since it has been grown with the greatest ease in past years at Washington, as we are informed by that experienced horticulturist Mr. Wm. Saunders, and also around Ithaca, N. Y., as we learn from Prof. Barnard.

Prepare a small bed of fine, loose, sandy, loamy soil, slightly mixed with fine manure. Mix the seed with dry sand, and sow carefully on top of the bed. Then with a common rake disturb the surface of the ground half an inch in depth. Sprinkle the bed every evening, until sprouted; too much water will cause injury. After it is well sprouted watering twice a week is sufficient. When about a month old, weed carefully. They should be transplanted to loamy soil during the rainy season of winter or spring.

EFFECTS OF THE POWDER.

ON FLEA-BEETLES.—*July* 9.—Tried the powder on young cabbage plants, for the purpose of driving off the flea-beetles which were very numerous, having entirely ruined many plants. Dusted the powder over the plants, but do not find it very effective, as the fleas are on the under side of the leaves and difficult to reach. Moreover, the powder does not adhere well to the glaucous leaves. The insects spring away upon dusting the powder over the leaves, and many evidently escape without carrying any of it with them. Did not observe that the powder affected any of them.

July 21.—Found the powder still upon the plants. (There has been no rain, and but little dew in the interval.)

Only two flea-beetles were found, and these were on the underside of the leaf.

ON BLISTER-BEETLES.—*July* 19.—Found the striped blister-beetle defoliating a large passion flower vine. Upon applying the powder, the insect was at once affected, and began to make vigorous efforts to remove the irritating substance by rubbing the legs against the body. In less than three minutes, however, it is unable to run, and it moves its legs in a drunken sort of way.

July 21.—One of the beetles, which yielded to the powder two days ago, lies helpless on its back, but keeps up a constant twitching of the last joints of the legs, showing life but nothing more. It is now more than fifty hours since it ceased to walk, and yet it is alive.

The powder dusted over the vine has completely freed the vine from its enemies.

August 2.—One week ago rain fell. A few beetles are now found about the vine.

ON CABBAGE WORMS.—*July* 19.—The imported cabbage butterfly (*Pieris rapæ*) is now to be found everywhere in the vicinity of cabbage patches. As they were found about thistle blossoms, an effort was made to dust powder upon them, as they rested, gathering the honey. This is easily done, but the creature is found to fly away and continue its search for food for some time. Of several so dusted only one is known to have yielded to the powder.

Four were caught and dusted with the powder, and allowed to fly about in the room, where they could free themselves, if possible, from the effects. In three minutes they showed signs of irritation, and in two more their movements were drunken, the power of flight rapidly yielding to the poison, which seems always to affect the limbs first. In ten minutes they were helpless, and after five hours not yet dead.

At the same time worms of this species were dusted, and in two minutes showed signs of pain, and grew rapidly helpless. A very little of the powder evidently would suffice for these.

In one instance about thirty of the larvæ, mostly full grown, were placed in a tin box, in which was dropped one of the blister-beetles that had adhering to its body such of the powder as remained after the beetle had struggled to clean itself. In an hour and a half from the time the box was closed (after placing within it the beetle) it was opened, and all but seven of the worms found dead, or dying, and they had avoided contact with the beetle by crawling to the top of the box.

The power of even a minute quantity of the powder is thus shown to be effective with these pests.

ON SQUASH BUGS.—*July* 23.—A pumpkin vine was found upon which were a few full-grown squash bugs, and hundreds of smaller ones—enough to entirely kill the vine in a short time. Upon applying the powder, the bugs did not seem to show much irritation, and it was even surmised that they would not yield to its effects. Four hours later, however, it was found that with hardly a single exception they were dead, or dying, and lay in great numbers on the ground directly under the very leaves upon which they had been feeding.

ON ROACHES.—*July* 24.—One of the clerks at the Treasury Department complained of the cockroaches infesting the desks at which they work. Powder was suggested, and tried upon one desk, and for a week not one has been found about the desk in question, though abundant about the adjoining ones.

EFFECT OF THE FUMES OF BURNING PYRETHRUM.

The pyrethrum was burned by placing it in a tin dish and applying a match. It took fire easily, and burned like sawdust, giving off considerable smoke.

The smoke was collected in a tight tin case with glass sides.

The first insects placed within were locusts and crickets. These held to the sides of the tin case for some four to five minutes in the dense fumes before they yielded and fell down. They acted much as other insects do when under the influence of pyrethrum (unburned).

Carnivorous beetles seemed to hold out even longer than the locusts.

Flies in a wire gauze fly-trap were subjected to the smoke by blowing it through the trap and burning it inside. They were greatly irritated, as shown by buzzing about, and by constantly rubbing the body with the legs, as if to free it from some irritating substance.

Although in an air with far less smoke in it, they yielded as soon as the locusts.

Nearly two tablespoonfuls of the powder was burned in the kitchen, with the windows closed.

The flies were soon affected in the part of the room where the smoke went, but only one was seen to become helpless.

Several gnats on the window became helpless in a very short time, and a mosquito soon yielded.

These last two instances were very marked.

It would seem that the insects tried were affected in the following order:

Ground-beetles.	Flies.
Locusts.	Mosquitoes.
Crickets.	Gnats.

—*American Entomologist.*

BACTERIAS IN THE ATMOSPHERE.

THE following are the contents of a scientific note by Mr. P. Miquel, of France, treating of a subject which at present interests all scientific men.

As the beautiful experiments of Mr. Pasteur have shown, the germs and eggs of bacterias are always present in the atmosphere, but their number is subject to incessant variations.

Mr. Miquel has made these variations a special study, and declares that the number of atmospheric bacterias is very small in winter, increases in spring, is at its height in summer and fall, and decreases rapidly in frosty weather. The same law will apply to the germs of the fungi; but while the grains of the mildew are abundant during the humid periods the number of the bacterias in the air becomes less and does not again increase until the ground becomes dry, so that the maximum number of the mildew microbes corresponds to the minimum number of bacteria-microbes and *vice versa*. Graphic curves would illustrate this in a very excellent manner.

So long as it is impossible to prepare a liquid which is able to produce the germs of all the schizophytes, we will never be able to ascertain the exact number of bacterias which traverse space. In experimenting with neutral boiling water, which is perfectly sterilized, we find that the average annual number of bacterias contained in the air is not over two hundred in one centimeter of air, a fact which might lead us to the assumption that there are a hundred times more of the germs of mildew contained in the air than of bacterias. Unfortunately, experience teaches us every day that the composition of thousands of nutritious substances has a great influence upon the development of microbes. As an example, we mention *Bacillus ureæ*, a very active agent of ammoniacal fermentation, an organism perfectly distinct from *micrococcus*, the cause of the fermentation in urea, which was made the subject of a special study by Messrs. Pasteur and Van Tieghem. The *Bacillus ureæ* grows very abundantly in the urine and in all liquids which contain urea, but cannot be produced and propagated in water that has been boiled; nevertheless this liquid is favorable to the production of a great number of species, and has, at least, the value of enabling us to make comparative studies.

In summer and in fall there exists one thousand germs of bacterias in one centimeter of air, as was ascertained by experiments at Montsouris. In winter it not unfrequently happens that this number diminishes to four and five, and on some days the dust of two hundred liters of air is incapable of producing any infection in the most changeable liquids. In the interior of habitations, providing the air is not excited by mechanical causes (such as rubbing or walking up and down) which stir up the dust which lies on the surface of objects, thirty or forty liters of air are necessary to produce fertility. Mr Miquel found that in his laboratory five liters of air was sufficient to produce an alteration of the boiled water, and that in the sewers of Paris, the particles which were contained in one liter of air effected a change of this liquid.

It will be seen how different these results are from those published by Mr. Tyndall. According to this scientist some cubic centimeters of air, in most cases, are capable of causing an infection of infusions of perfectly different kinds. The interest connected with the study of these bacterias, since it has been assumed that they are the cause of contagious diseases, has led Mr. Miquel to make special experiments, in which he endeavored to compare the amount of bacterias contained in the air with the death rate at the same season. These experiments, which were made during the period from December, 1879, until June, 1880, resulted in the discovery that each increase of the amount of bacterias contained in the air was followed within a week by an increase of deaths caused by epidemic diseases. Perhaps this may be a simple coincidence, and the author of these experiments hesitates to give his definite opinion regarding them until he has extended his researches; but we should remember that if these zymotic diseases, as is usually assumed, are caused by the infections of our organisms through certain miasmatic agents of fermentation, then these diseases will occur in the greatest number at the dry time of the year, when these germs of infection are the most abundant.

Mr. Miquel has announced that he will shortly give more detailed accounts of some interesting facts concerning the diffusion of bacterias in the atmosphere, in which he will prove that, contrary to the opinion of most authors, the vapor of water which rises from the ground, from rivers, and from masses which are in a full state of putrefaction, is always micrographically pure, that a gas which comes from buried matters which are decomposing is always free from bacterias, and that impure air itself when it is led over putrefying substances, far from becoming loaded with microbes, is completely purified, provided this putrid filter is in a certain state of humidity.

Finally, Mr. Miquel proposes to indicate some means by which these deadly germs which carry with them the infections of contagious diseases and their evil consequences may be prevented from spreading.

JUPITER.

PROFESSOR G. W. HOUGH has made a very interesting report to the directors of the Chicago Astronomical Society, from which we take the following concerning the telescope, and observations made with it, during the past year, at the Dearborn Observatory:

THE EQUATORIAL TELESCOPE.

The equatorial has an object glass of 18½ inches aperture and a focal length of 23 feet. It is provided with a parallel wire micrometer and driving clock. The eye pieces used with the micrometer magnify from 120 to 925 diameters. The value of the micrometer screw was determined by transits of equatorial stars recorded on the chronograph, and was found to be essentially the same as has heretofore been used by Mr. Burnham for his double star measures.

Observations have been made on almost every favorable night, usually on such objects and phenomena as cannot be reached with smaller instruments.

My own experience during the past year, taken in connection with what has hitherto been accomplished by Mr. S. W. Burnham, on difficult double stars, leads me to believe that it is superior to any telescope in Europe, and is only surpassed in size and light power by the great refractor of the United States Naval Observatory.

Mr. Burnham speaks on this point as follows: "I know of no object, faint or otherwise, which has been seen at Washington or elsewhere, that cannot be seen perfectly here and accurately measured."

The object glass seems to be equally good up to its full capacity, since reducing the aperture has no appreciable effect on the definition.

An instrument like this should principally be devoted to difficult objects, and for the study of physical phenomena requiring high magnifying power combined with good definition.

The faint periodic comet (Tempel II., 1867) was observed on six nights by myself, and on two nights by Mr. Burnham, between June 7 and June 18.

The comet discovered by Swift was observed on eleven nights by myself, and on two nights by Mr. Burnham, between June 23 and August 16.

On the 27th of August last, in connection with Prof. Colbert, I began a series of observations on the planet Jupiter. These were continued on every favorable night during the whole opposition, the last one being secured on February 11, 1880. Owing, however, to unusually bad weather, but few observations could be made after the middle of October. As some of these have an important bearing on the physical constitution of that planet, it may be of interest to the society to give a brief abstract of the observations made, and the conclusions drawn from a discussion of them.

THE FIGURE OF JUPITER.

It was early recognized by astronomers that the disk of Jupiter was elliptical. The amount of ellipticity, as determined by different observers, varies from 1–13·5 to 1–20, showing a very large margin of uncertainty.

With a magnifying power of 638, the disk of the planet was measured on eight nights by myself, and on six nights by Prof. Colbert. My own observations include eight measures of the polar, eight of the equatorial, and five of the conjugate diameters. Prof. Colbert's includes six of the polar and five of the equatorial.

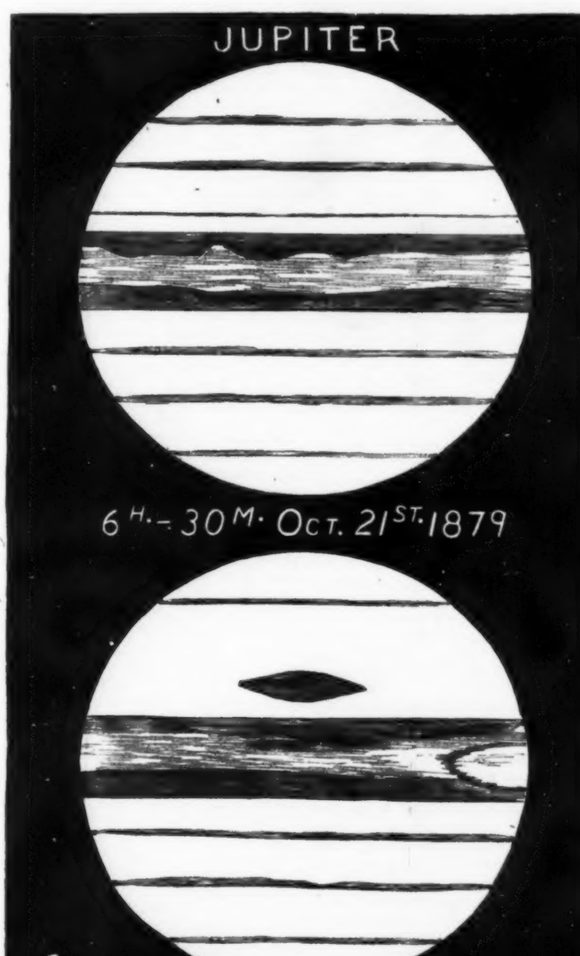
With a magnifying power of 389, the polar and equatorial diameters were measured on five nights by Prof. Colbert and myself.

The reduction and discussion of these observations give the ellipticity as follows:

Magnifying power, 638.

Hough	1–13·23
Colbert	1–16·73
Power, 389	1–16·76

The transit diameter was also observed with the chronograph on six nights. Using the ellipticity as given by my own observations with power 638, and computing the values of the conjugate and transit diameters, making angles of 45° and 24° respectively with the major axis of the spheroid, the difference between observation and computation is found to be 0·04" and 0·01", quantities entirely insignificant, showing the figure of Jupiter's disk to be a true geometrical spheroid.



It may be stated that the English Nautical Almanac uses Struve's value of the diameters, 38·33" and 35·54", ellipticity 1–13·71, while the American Nautical Almanac uses 38·53" and 36·18", ellipticity 1–16·40.

The absolute value of the diameters was observed as follows:

	Polar.	Equatorial.	Conjugate.	Transit.
Hough, power 638,	36·319"	38·704"	37·520"	38·295"
Colbert, " "	36·030"	38·316"		
H. and C., " 389,	37·388"	39·764"		

A comparison of the absolute value of the diameters, as measured with powers 638 and 389, led to an interesting result, and one which has an important bearing on the micrometrical measurements of luminous disks.

On looking at the moon, or any luminous object, either

with the naked eye or telescope, it appears larger than it really is. This enlargement is technically called irradiation. The law fixing the amount of irradiation is unknown. Our knowledge on this subject is almost entirely speculative. It is supposed to depend on the size of the object glass, the condition of the image, the eye of the observer, and possibly the magnifying power. Small telescopes are presumed to give a larger value for this quantity than large ones.

The excess of diameter, as given by power 389, amounts to 1·18″ on the polar and 1·21″ on the equatorial diameters at the mean distance of the planet from the earth, or a mean difference of 1·56″ as observed. The values being so nearly identical for both diameters, measured by two observers, shows it to be a real quantity, and not the result of erroneous measurement.

An investigation, having for its object the determination of the law defining the amount of irradiation for micrometer measurements of luminous disks, is one on which the great refractor could be very profitably employed.

EQUATORIAL BELT OF JUPITER.

The angle of position of the north edge of the equatorial belt was determined by micrometer measurement on eighteen nights between August 27, 1879, and January 14, 1880. These observations show that the belt had the same direction around the whole circumference, that it maintained this direction without any change during the whole opposition, and that it was precisely parallel to the equator of the planet.

The observed mean position of the belt was —23·7°.

The computed mean position of Jupiter's equator —23·7°.

The distance of the north edge of the belt from the planet's equator was determined on ten nights, between September 3, 1879, and January 14, 1880. The observations indicate that it was fixed in latitude; it did not shift north or south an appreciable amount during the opposition. The width of the belt was also measured on nine nights; and although the measures differ among themselves to the extent of one second of arc, yet it is difficult to decide whether any radical change took place in its apparent size during the period covered by the observations.

The position on the disk of the six faint belts, three in the northern and three in the southern hemisphere, were determined with the micrometer a number of times between September 10 and October 24.

The following numbers indicate the belt system of Jupiter during the opposition of 1879. The observations have all been reduced to the mean distance of the planet from the earth, and show the distance of each belt from the equator.

Equatorial diameter, 38·70″. }
Polar diameter, 36·32″. }

No.		North.	
1	+	15·10″.	
2	+	9·78″.	
3	+	5·98″.	
4	+	2·59″.	} North edge equatorial belt.
	—	3·18″.	} South edge equatorial belt.
5	—	5·83″.	
	—	6·94″.	Red spot.
6	—	9·83″.	
7	—	13·84″.	

An examination of these numbers shows that the belts were arranged symmetrically on either side of the equator, the great red spot coinciding very nearly with belt 5.

It may be proper to remark that the faint belts are not seen with small instruments. All the pictures of Jupiter during the past opposition, which have come to my notice, simply show a darkening toward the poles, and not separate belts. That they were permanent features cannot be questioned, as they were always seen under ordinary atmospheric conditions up to the end of October. The power usually employed was 638. When the definition was not good enough to use this power, the observations were not considered of any value for determining suspected physical changes.

The middle of the great equatorial belt was subject to gradual change in its appearance between September 1 and November 1. During the earlier portion of this period it was made up essentially of three separate belts, approximately equal in width. It gradually formed in two almost equal portions, with a rift extending through a large part of the circumference of the planet.

The woodcut, page 3941, shows the great red spot, the belt system, and to some extent the structure of the great equatorial belt.

The color of the equatorial belt was reddish-brown—brick color; that of the great spot was similar, but more brilliant.

The equatorial belt was visible up to the edge of the disk with very slight diminution in color. The red spot was frequently seen at the edge, when only partially on the disk, and the color appeared sensibly the same as when near the center.

After December 1, the faint belts in the northern hemisphere continued visible, but on the southern hemisphere there was simply seen faint markings on the center of the disk.

RED SPOT.

One of the most remarkable features on the disk of the planet was the great red spot on the southern hemisphere. The study of this object was begun on September 11 and continued until February 10, 1880.

Its position from the equator was measured on eight nights, including one by Prof. Colbert.

The observations during September and October show it was fixed in latitude during that period. A single observation on February 10, after an interval of nearly three and one-half months, shows an apparent displacement of one second of arc, possibly due to unavoidable error of measurement.

Its length and breadth were measured on nine nights, of which one measure of length and two of breadth were made by Prof. Colbert.

The mean value of its length, at the mean distance of Jupiter from the earth, was 12·73″, and the breadth 3·56″, as seen on the center of the disk. The length appeared to vary to the extent of 3″ of arc, and the breadth about the same amount.

Owing to the irregular outline of the object it is difficult to decide whether any actual change took place during this interval, or that the discrepancies in the measures are simply due to bad seeing. Measures made during the present opposition will, of course, afford positive information on this point.

Observations on the position of the spot for ascertaining the rotation period of the planet were begun on September 25 and concluded on February 10, 1880. They consist of micrometer measurements of the distance of the center of the spot from the two limbs of the planet disk. At my request Prof. Colbert has made the computations necessary for determining the rotation period. He has obtained 9ʰ 55ᵐ 34·2ˢ as the time of sidereal rotation.

On the morning of May 7, 1880, the spot was seen on the disk, and its time of transit over the central meridian approximately determined by micrometric measurements. Owing, however, to the low altitude of the planet, and the approach of daylight, no measures of its length, breadth, or position could be secured.

The above period satisfies all the observations, including that of May 7, within the probable errors of observation.

The value hitherto considered the most probable was 9ʰ 55ᵐ 26ˢ, differing about eight seconds from the present one, or equivalent to an error of one-quarter rotation in one year.

Observations made during the present opposition, combined with those of last year, will probably serve to determine the rotation period within 0·10ˢ.

The diameters of the four satellites of Jupiter were measured on three nights, with the following results, at the mean distance:

1st.	2d.	3d.	4th.
1·114″	0·980″	1·778″	1·457″

SATELLITES OF URANUS.

In the month of March we began the observation of the satellites of Uranus. The two inner satellites, according to the Washington observers, are the most difficult well known objects in the heavens.

When I undertook their observation it was doubtful whether they would be distinct enough in our telescope to make satisfactory micrometric measurements. I am happy, however, to state that near the time of opposition they can readily be seen and measured under ordinary atmospheric conditions.

The observations on the two inner satellites were not begun until a month after opposition. And, notwithstanding an unusual amount of cloudy weather, Umbriel, the faintest, was seen on three nights, and Ariel on four nights.

The two outer satellites are comparatively easy objects at any time within two months of opposition.

ALTERNATIVE CURRENTS AND THE ELECTROMOTIVE FORCE OF THE ELECTRIC ARC.

WHAT resistance does the space which separates the two carbon points offer to the passage of electricity? Does the electric current traverse this space continually, or only when its intensity has reached a certain degree? Does the arc act only as a simple resistance, or, as announced by Mr. Edlung, as an electromotive force? These questions are answered by Mr. M. J. Joubert as follows: At the moment when the intensity of the current is null, then the difference of the potential energy between the two carbons is equally null; but in an inappreciable moment of time this difference reaches a strength of 40-45 volts, which it conserves, without variation, until the moment when the current becomes again very weak. The final downfall is very sudden, but, nevertheless, I have been able to follow it in its details, and to determine the important fact that the potential difference not only remains unaltered during the whole period when a current whose mean intensity remains the same is passing, but also when this mean intensity is made to vary within certain limits. I must, however, add that this difference diminishes when the intensity increases, and that the variation reaches the maximum of 4 or 5 volts. The explanation of these facts is evident. The resistance of the arc is very weak; it varies with the temperature and diminishes as the temperature increases. The difference of the potential energy between the two carbon points is due, for the most part, to an electromotive force, which is independent of the intensity, and can be valued at 30 volts. Things go on between the two carbon points exactly the same as between the electrodes of a voltameter. A phenomenon of polarization takes place, then follows a downfall of potential energy, and from that moment the work produced depends solely upon the quantity of electricity which passes between the carbons and is proportionate to it.

PERHAPS the most remarkable operation hitherto recorded in the history of submarine telegraphy is that which has just attended the work of the Eastern Telegraph Company's ss. Chiltern. In 1870 a cable was laid running off the coast of Portugal in 2,000 fathoms of water, and recently persevering efforts have been made to grapple and raise this old cable. The general idea is that a cable after so long an immersion is rotten, and cannot be raised from such immense depths, but this success will do much to dispel these ideas. The cable has been successfully grappled and raised, and was found to be as good and as strong as when laid ten years ago. To grapple a mere thread in 12,000 ft. of water may well be termed a triumph, and great credit is due to the perseverance of the company, and the ability shown by Captain Goodsall and the chief electrician, Mr. Phillips.

PARASITES IN THE MUSCLES IN TYPHOID FEVER.

AT the regular meeting of the London Pathological Society on April 20, Dr. G. Buchanan read a paper on "Some Appearances, probably of Parasites, in the Voluntary Muscles in Enteric Fever." The observations which it described were made by his colleague, Mr. W. H. Power, who was led to investigate the subject by finding that an epidemic on board the training ship Cornwall, supposed to be typhoid fever, was really trichinosis. He thereupon commenced the examination of the voluntary muscles in typhoid fever. The first case examined was a young man in St. Thomas's Hospital, who died from peritonitis set up by perforation of a characteristic enteric ulcer. In the pectoral muscle were found what were taken to be parasitic worms, one or more of which were seen in each specimen, and which seemed to be still alive. Their dimensions were wholly different from those of trichinæ spiralis, being only a quarter the size of this parasite. They resembled nematoid worms, both in the proportion of their breadth and length, and in the presence of an interior canal, apparently interrupted by some intervening organ or tissue. Another case of undoubted typhoid, dying in the Seaman's Hospital, under the care of Dr. Curnow, was also examined, and in it, too, the same bodies were found, but in neither case were they so plentiful as was at first supposed. They were not found in all muscles equally, none having been found in the diaphragm, nor are they uniformly disseminated through a given muscle. Many slides may be examined without meeting with one. Certain much smaller bodies, having a possible relation to the larger parasites, were also found more abundantly. They were with difficulty distinguished from the muscle, and any slight interference with the slide often resulted in their being lost sight of altogether. With advancing decomposition, the parasites, but not the smaller bodies, were found to be more numerous.—*Lancet.*

THE NEW ROUTE TO SIBERIA.

THREE Swedish steamers have been purchased by Russia and dispatched to the town of Semipalatinsk, near the Chinese frontier, in Mid-Siberia. The route taken will be round Norway, and past the White Sea and Nova Zembla to the Kara Sea and Obi River. On reaching Tobolsk they will find there several barges laden with troops and stores, which it will be their duty to tow up the Irtish to Semipalatinsk, distant a few days' march from the Chinese frontier. Thanks to Professor Nordenskjöld, Russia will be able to concentrate troops on the Chinese border in half the time that would have been considered possible a few years ago, when the utilization of navigable Siberian rivers for military transport purposes was hardly dreamed of by the Czar's ministers.

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